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NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. X. September, 1895. No. 1.

This Association, as a Body, is not responsible for the statements or opinions of any of its members.

ANNUAL MEETING.

YOUNG'S HOTEL, BOSTON, June 12th, 1895.

President Stacy presided, and the following members were present:

MEMBERS.

Everett L. Abbott, Chas. H. Baldwin, Jos. E. Beals, Dexter Brackett, C. E. Chandler, Geo. F. Chace, R. C. P. Coggeshall, Lewis P. Collins, H. W. Conant, F. W. Dean, Albert S. Glover, W. J. Goldthwait, John C. Haskell, Wm. B. Hawes, David B. Kempton, Patrick Kieran, Horace Kingman, James W. Locke, Wm. McNally, H. H. Nash, Jr., Fred. G. Perry, Geo. S. Rice, W. H. Richards, Geo. J. Ries, J. Herbert Shedd, Geo. A. Stacy, Lucian A. Taylor, Robert J. Thomas, J. Alfred Welch, J. C. Whitney, W. P. Whittemore, E. T. Wiswall, Geo. E. Winslow, W. G. Zick.

The following companies were represented:

Thomson Meter Company, National Meter Company, Hersey Manufacturing Company, Neptune Meter Company, R. D. Wood & Company, Deane Steam Pump Company, Holyoke Hydrant & Iron Works.

The Secretary presented the following applications for membership, which had been endorsed by the Executive Committee:

RESIDENT ACTIVE.

Herman Gregg, Civil Engineer, Waltham, Mass.
Frank W. Hodgdon, Water Commissioner, Arlington, Mass.
Morris Knowles, Civil Engineer, Lawrence, Mass.
Walter W. Patch, Civil Engineer, Boston, Mass.
Sidney Smith, City Engineer, Rutland, Vt.
W. J. Sands, Mechanical Engineer, Boston, Mass.

NON-RESIDENT ACTIVE.

G. S. Williams, Engineer Water Department, Detroit, Mich.

The Secretary was instructed to cast the ballot of the association in favor of the applicants, and they were declared elected.

The President then announced the following as a committee to nominate officers for the ensuing year: John C. Haskell, Albert F. Noyes, Patrick Kieran, H. G. Holden, Freeman C. Coffin.

On Motion of Mr. Coggeshall it was voted, that when the meeting adjourned it be to meet at Burlington, Vt., Sept. 11, 1895.

Adjourned.

The members and guests, including ladies, then took a carriage drive through the Boston Park System and Arnold Arboretum, and also visited the Chestnut Hill Pumping Station, to see the new high duty Leavitt pump. The trip, which was arranged by Mr. Dexter Brackett, was thoroughly enjoyable.

PROCEEDINGS OF THE FOURTEENTH ANNUAL CONVENTION.

BURLINGTON, VT., September 11, 12 and 13, 1895.

The meetings of the Convention which were held in the hall of the Young Men's Christian Association on the morning, afternoon and evening of September 11th, evening of September 12th, and morning and evening of September 13th were well attended.

MORNING SESSION.

WEDNESDAY, September 11, 1895.

The Convention was called to order by President Stacy.

On motion of Mr. Coggeshall, the reading of the minutes of the last meeting was dispensed with.

The President introduced His Excellency, Governor Woodbury, of Vermont, who spoke as follows:

ADDRESS OF WELCOME BY GOVERNOR WOODBURY.

Mr. President and Gentlemen of the New England Water Works Association:

It was the expectation and desire that His Honor, Mayor Van Patten, should welcome you to the city of Burlington. It is my pleasant, although unexpected privilege of appearing as a substitute in his place, to welcome you to the Queen City of Vermont; and I also may say that I voice the sentiment of the people of the State of Vermont, if in my official capacity I welcome you to Vermont, and I do so most heartily. I do not know that the cordiality of our invitation to you to come to Burlington would have been so intense if we had supposed that you would have brought so much water with you at one time, as descended upon us this morning. But owing to our ample sewers and the conformation of the ground, the water has passed off into the lake, ere this, so that this afternoon, if the rain does not continue, you can walk about Burlington dry shod.

I think it is very fitting that you should come to Vermont, especially to the shores of this beautiful sheet of water, Lake Champlain, because you know Vermont believes in water, and does not believe in much of anything else. The fact is that we do not allow anything to be sold here except plain water, and perhaps soda water, or something of that kind, ginger ale, etc., so it is peculiarly appropriate that men who represent the branch of industry you do should come to this State that you may talk about the beverage which Vermonters almost exclusively deal in and use.

You represent an industry which is of vital importance to the human race, that of water, and of pure water. And it is through these meetings, I judge, although I am not familiar with them, and the discussions which arise in them, that the water supplies are constantly improving in the New England States. These discussions cannot fail of being of great benefit to the people whom you supply. In our own case here, in Burlington, the discussions which, perhaps, started in your Association, but were taken up actively by our own people, have resulted in our obtaining within the last two years an ample supply of what we believe to be as pure water as is found in New England.

I know that you do not care to listen to a speech this morning, and I will not inflict one upon you. I can assure you that we ap-

preciate the selection of Burlington for the holding of this Convention, and we sincerely hope that your stay with us, and that of your wives and daughters and invited guests, may be a pleasant one, and we trust that the elements will be propitious on the morrow, so that you may enjoy a sail upon our beautiful lake and your visit to that wonderful work of nature, Ausable chasm; and that when you leave Burlington you will be glad you have been here, as I am sure we shall be. Wishing you a pleasant and profitable time, I will now give way that you may proceed to the regular business of the convention. (Applause.)

RESPONSE BY PRESIDENT STACY.

Your Excellency: Previous to this meeting, The New England Water Works Association has held its conventions in every State in New England with the exception of Vermont. For a long while the eyes of the directing force of the Association have been turned toward this State as a desirable place in which to hold our meetings where we could gain inspiration for our work, to make us better fitted for the labors before us. And last year it was a unanimous and hearty vote and expression of opinion that we should hold our next convention in Vermont. And as long as we had delayed for so many years before visiting the State, we were determined to visit the very heart of it, and we selected Burlington as our objective point; and the reception we have received shows that we did not make a mistake. Allow me to thank you in behalf of the New England Water Works Association, for your hearty and cordial welcome, and permit me to extend to you, and to the City Government and to the citizens of Burlington, and of Vermont, a cordial invitation to attend any and all of our meetings.

The Convention then proceeded to the regular order of business.

ELECTION OF NEW MEMBERS.

The Secretary presented the following list of applicants for membership, with the approval and recommendation of the Executive Committee:

RESIDENT ACTIVE.

H. M. McIntosh, City Engineer, Burlington, Vt.; Alex. S. Dawson, Civil Engineer, Boston, Mass.; H. L. Colby, Civil Engineer, Salem, Mass.; Forrest E. Bisbee, Superintendent, Auburn, Me.; D. H. Gilderson, Superintendent, Bradford, Mass.; Richard J. Flynn, Engineer, Brookline, Mass.; Orrin B. Bates, Superintendent, Clinton, Mass; Jas. F. Bigelow, City Engineer, Marlboro, Mass.; Chas. F. Murphy, Water Inspector, Marlboro, Mass.; L. C. Greene, Water Commissioner, St. Albans, Vt.

NON-RESIDENT ACTIVE.

Daniel B. McCarthy, Superintendent Water Works, Waterford, N. Y.; Henry Henry E. Eastman, Superintendent Water Works, Westport, N. Y.; M. L. McDonald, Jr., Superintendent Water Works, Santa Rosa, Cal.; Warren R. Kinsey, Civil Engineer, Newark, N. J.; John H. Myers, Jr., Civil Engineer, Brooklyn, N. Y.; Wm. Clayton, Superintendent, Newtown, N. Y.; J. B. Fish, Superintendent, Scranton, Pa.; Jas. E. Booke, Princeton, N. J.; Chas. E. Eddy, President Water Company, Plattesmouth, Neb.

ASSOCIATE.

The Goulds Manufacturing Company, Seneca Falls, N. Y.; H. Mueller Manufacturing Company, Decatur, Ill.

On motion of Mr. Noyes, the Secretary was directed to cast the ballot of the Association for the applicants, which he did, and they were declared elected to membership.

ADDRESS OF PRESIDENT STACY.

Gentlemen of the New England Water Works Association: We have assembled to-day in this pleasant city to take up the business of our Fourteenth Annual Convention which was called in Boston last June and adjourned to this time and place, for reasons that are probably well known to you all.*

The records of the past year show that we are stronger, both numerically and financially, than we were at the beginning of the year. This, I can say, has been the record of every year since that comparatively small but enthusiastic body of water works men, twenty-seven in number, in June, 1883, organized and brought into being the New England Water Works Association; truly they builded better than they knew, for it is safe to say that, not one of the founders of this organization could possibly have foreseen that it would expand and grow to its present proportions. To-day it stands without a peer, and so broad has been its platform, and so wise and harmonious has been its management, that it has attracted

*As mentioned in the June number of the *Journal*, page 200, it was the original plan to hold the convention in Burlington in June, 1895. But after this arrangement had been made, it was announced that the annual convention of the American Society of Civil Engineers was to be held in Boston on the dates selected, and as many of our members were desirous of attending that convention, and as for other reasons it was impracticable to hold the convention at any other time in June, it was decided to call the convention in Boston on the date required by the constitution, and then to adjourn without transacting business, to Burlington, in the second week of September.

to its ranks men of every station, from the humblest superintendent to the scientist and engineer of world-wide reputation. Our membership, June 1st, 1895, was 401 active, 81 associate, and five honorary members; a total of 487, a gain of 44—one of the largest in the history of the organization. Out of this large membership, for the year ending June 1st, 1895, death had removed but two of our members: Phineas Ball died Dec. 19th, 1894. He joined this association June 10th, 1886, and was a constant attendant at our gatherings, when health and business permitted. His genial countenance, pleasant smile, and wise counsel, will be much missed at our meetings. Lincoln C. Haywood, died Jan. 15th, 1895. He had been a member but six days. Since the date of our Annual Meeting, June 1, two more of our active members have been removed from our ranks by the hand of death. John L. Harrington, the successor of the late Hiram Nevons, Superintendent at Cambridge, died Aug. 10th, 1895. He joined the association in June, 1887, and was a member of the Finance Committee, and active in promoting the interests of the association. Marshall M. Tidd, died Aug. 20th, 1895. He was an eminent hydraulic engineer, and an active participant in our meetings, a genial companion and a firm friend, and did much to make our meetings interesting and instructive.

We have had five meetings since our annual convention in June, 1894. The first was our fall field day, Sept. 22d, when fifty-two of our members, and their ladies and friends, took a special car for the Crawford House, where we arrived in the afternoon. From this time on, walks and drives among the grand and beautiful scenery for which that place is noted, occupied the time until the morning of the 24th, when we started for home, a tired but happy party. The weather was perfect, and nothing occurred to mar the pleasure of the trip, and we are indebted to Mr. Dexter Brackett for his untiring efforts in our behalf and for a large share of the pleasures we enjoyed. Meetings have been held at Young's Hotel in December, January, February and March, all of which were well attended.

The papers presented at these meetings, and the discussions following them, have been instructive and much enjoyed, and it is impossible for one connected with water works enterprises to attend the meetings of this association without becoming better fitted to

cope with the difficulties that are sure to come to him in his business, and I believe that every city and town should oblige the managers of its water works to attend the meetings of this association; certainly no man who is worthy of his position can do so without becoming more valuable to his employers, and if they made it a part of his duty to attend, and paid his expenses, it would yield a better return than any other investment they could make.

The *Journal*, published quarterly by the association, is a valuable addition to any water works library. Its numbers contain a fund of theoretical and practical knowledge in regard to every detail, from the largest to the smallest, of water works construction and management. We certainly owe a debt of gratitude to its founders, and to the editors who have so ably managed it.

The question of permanent headquarters has been before the association for some time, but no opportunity to secure them, within the means of the association, has presented itself until recently. A number of meetings have been held during the past summer by the executive committee, and the committee appointed at Hartford, in relation to the matter, a detailed report of which will be made during this convention. I believe that if permanent headquarters can be secured within the means of the association, without increasing the tax on the members, that it will be of great benefit to the association as a whole.

As the demand for water grows greater and greater, the problems we are called upon to solve, grow in magnitude and number. The supply, its quality, and its protection from pollution, the prevention of waste, are live questions that require our best thought and study. We are all agreed that the supply should be wholesome and abundant, to be used freely for all necessary purposes, but waste of water is like waste by fire; a total loss to the people who are taxed to maintain the works. There is, naturally, a difference of opinion as to the best way to reach the desired results, and a free and full discussion of these and kindred subjects, as they come before us from time to time, will materially assist us in solving these problems. Let no one hesitate to give to the association his experience, no matter how small, in the management of his business, whether it is a success or not, for we often learn more valuable lessons from our failures than we do from our successes, and small things are, in the aggregate, a large factor in the progress of events in our every day lives.

I wish to thank you all for the honor you have conferred on me in electing me to the presidency, and for your courtesy and hearty co-operation; what measure of success the association has attained the past year is due more to your work than it is to mine; to your quick response to every call and your unflagging interest and support of the officers of this association.

Every member regretted the necessity that caused the resignation of our former Secretary, but we have the pleasure of knowing that while he was obliged to resign the office he had so long and ably filled, we retain as a member one who has done so much to make the association what it is. We are indeed fortunate in securing so able a man as our present Secretary to fill the vacancy; he has been untiring in his efforts in behalf of the association.

And now as we turn our faces to the future, let us not forget the duty we owe to ourselves and to the association; let us do our part in making all the meetings of this convention profitable and interesting; and in the year to come let us encourage our officers by our presence and work, remembering that in a large measure the continued success of the association rests with us; so that my successor may have the pleasure of saying, at the next annual convention, as I have the pleasure of saying now, our association is stronger, larger, and more powerful for good than it ever was before.

The Treasurer then submitted his annual report as follows:

ANNUAL REPORT OF THE TREASURER.

George E. Batchelder, in Account With the New England Water Works Association.

1894.	DR. TO AMOUNT RECEIVED.	
June 15.	Received from Cambridge National Bank	$ 79 56
"	" " Savings Bank	28 48
"	" Cambridgeport Savings Bank	1,190 36
July 15.	" R. C. P. Coggeshall	665 05
Oct. 22.	" "	2,000 00
1895.		
Jan. 22.	" "	1,017 75
Feb. 15.	" Dexter Brackett, Secretary pro tem	258 25
June 5.	" J. C. Whitney, Secretary	475 85
1895.	ACCRUED INTEREST IN	
Aug. 1.	Mechanics Savings Bank	19 76
" 1.	People's Savings Bank	32 16
Sept. 1.	City National Bank	21 80
		$ 5,789 02

1894.		Cr. By Payment To	
July	3.	Bacon & Burpee	75 00
"	3.	Harold L. Bond	6 00
"	3.	Thomas P. Taylor	20 75
"	3.	Walker, Young & Co	6 25
"	12.	Boston & Albany Railroad Co	30 00
"	12.	James B. Fuller & Co	14 00
"	12.	W. N. Hughes	33 00
"	12.	E. D. Leavitt	26 25
"	19.	Tilly Haynes	112 00
Aug.	4.	Hattie F. Milligan	20 00
Sep.	14.	Electro-Light Engraving Co	10 42
"	14.	F. T. V. Groll	5 25
Oct.	8.	Robert Burlen	17 15
"	8.	W. N. Hughes	5 50
"	8.	Putnam, Davis & Co	12 00
"	8.	W. H. Richards	97 18
"	8.	Engineering News Publishing Co	1 85
"	8.	The Heliotype Printing Co	13 50
"	22.	The Day Publishing Co	201 40
Dec.	4.	A. L. Ward	10 00
"	13.	R. C. P. Coggeshall	398 34
"	17.	Young's Hotel	20 00
"	18.	George A. Stacy	14 00
"	20.	Mercury Publishing Co	201 39
1895.			
Jan.	5.	W. H. Richards	89 74
"	5.	The Day Publishing Co	256 17
"	12.	Young's Hotel	10 00
"	31.	The Heliotype Printing Co	16 00
Feb.	12.	Walter T. Almy	28 32
"	19.	Young's Hotel	10 00
Mar.	14.	Dexter Brackett	41 67
"	14.	R. C. P. Coggeshall	110 53
"	14.	Electro-Light Engraving Co	1 08
"	15.	Young's Hotel	10 00
"	21.	Hub Engraving Co	55 80
"	22.	"	1 94
Apr.	2.	Bacon & Burpee	59 50
"	12.	W. H. Richards	100 71
"	12.	The Day Publishing Co	233 95
"	12.	Lettice R. Washburn	13 99
May	13.	Hub Engraving Co	10 89
June	13.	Mercury Publishing Co	108 20
"	21.	J. C. Whitney	181 61
July	12.	W. H. Richards	93 33
"	17	The Day Publishing Co	331 33
			$ 3,115 99

BALANCE ON HAND.

People's Savings Bank	$ 1,032 16
City National Bank	440 87
Safe Deposit and Trust Co	1,200 00
	$ 2,673 03

Respectfully submitted,

GEO. E. BATCHELDER, *Treasurer.*

We hereby certify that we have examined the above account and approve it as correct.

A. R. HATHAWAY,
FRANK A. ANDREWS, } *Finance Committee.*

On motion of Mr. Coggeshall, it was voted to receive and accept the report, and that it be placed on file and spread upon the records.

The Secretary submitted the following as his report:

REPORT OF THE SECRETARY.

Summary of Statistics Relative to Membership for Year Ending June 1, '95.

ACTIVE MEMBERS.

June 1, 1894, total active membership		365
Withdrawals during year		10
		355
INITIATIONS:		
June, 1894	24	
December, 1894	7	
January, 1895	3	
February, 1895	8	
March, 1895	4	
	46	
June 1, 1895, total active membership		401

HONORARY MEMBERS.

June 1, 1894, total honorary membership	5	
June 1, 1895, total honorary membership		5

ASSOCIATE MEMBERS.

June 1, 1894, total associate membership	73	
Withdrawals during year	2	
	71	
INITIATIONS:		
June, 1894	8	
December, 1894	2	
	10	
June 1, 1895, total associate membership		81
June 1, 1895, total membership		487

A gain for the year of 44.

Summary of Receipts for Year Ending June 1, 1895.

DR.

Balance from old account		$ 665.05
Received for advertisements		1,695.00
" initiation		307.00
" dues		1,489.00
" Journals		240.00
" badges		21.85
" electrotype		1.00
		$4,418.90

CR.

June 20.	Paid Geo. E. Batchelder, Treas.		$ 665.05
Oct. 20.	"	"	2,000.00
1895.			
Jan. 19.	Paid Geo. E. Batchelder, Treas.		1,017.75
Feb. 13.	"	"	260.25
June 1.	"	"	475.85
			$4,418.90

On motion of Mr. Richards, it was voted that the report be received and placed on file, and that a copy be spread upon the records.

PERMANENT HEADQUARTERS.

The President called upon Secretary Whitney for a report on behalf of the Executive Committee on the subject of permanent headquarters for the association.

THE SECRETARY. The association has had under consideration for the last five years the subject of permanent headquarters. Up to the present year the financial conditions have been such that it seemed hardly advisable to take any decisive steps; but during the present year the Boston Society of Civil Engineers, which has been considering the same subject of permanent headquarters, has secured an option upon some desirable rooms in the new Tremont Temple building in Boston, and has wished to have some other society join with them in occupying the rooms and in meeting the expenses. The rooms which they wish to secure will cost about $1,400 or $1,500 a year. The Boston Society, which is now occupying quarters which are not adequate for its needs, has an arrangement with a dealer in supplies to occupy desk room, and take care of the rooms and share the expense. This arrangement the Boston Society wished to continue with the same concern in their new lo-

cation, and this concern has agreed to contribute towards the expense $500, to furnish a telephone free of charge, and to look after the rooms, to keep the books arranged in order, etc. This $500 reduces the expense to be met by both associations to $1,000. The Executive Committee of the New England Water Works Association made an offer to the Boston Society of Civil Engineers agreeing to pay $400 of that amount, this sum of $400 to include all expenses, the rent of the rooms, light and heat and care; so that the total expense to the Water Works Association was not in any case to exceed $400. The offer was made for a term not exceeding three years. It was also agreed that neither society should allow a third society to use the rooms in any way without the consent of the other society, so that no third society should be allowed there without unanimous consent. That offer the Boston Society still have under consideration. The President of the Boston Society of Civil Engineers, Mr Albert F. Noyes, is a member of the New England Water Works Association, and is now with us, and if there is anything to be added in regard to the position of the Boston Society in the matter, he can explain it.

MR. NOYES. I do not know that there is anything to add to the report that the Secretary has made, except this: He has stated that the committee of the Boston Society, having the matter in charge, had obtained an option on certain rooms, and that is true; but when they came to examine the rooms they found that they were not as large as they were shown on the plan which had been submitted to them. So a proposition was made to the Executive Committee of the Tremont Temple building for rooms which would give an area equivalent to that for which we had previously negotiated, and the committee still have that under advisement.

The rooms for which we are negotiating are about 18 feet wide by 56 feet long; there will be a small section taken out for an office, leaving a space something like 18 feet by 45 or 50 for the libraries of the two associations. It has been assumed that one section would be set apart for the library of the New England Water Works Association, and another section for the library of the Boston Society of Civil Engineers, with free access to both libraries for the purpose of reference, to the members of both societies.

There is a large hall adjoining the rooms, and a proposition has also been made for renting that hall for the regular meetings of

the Boston society, and undoubtedly similar arrangements could be made for any meetings of the association which might be held in the city of Boston.

It was also thought by the members of the New England Water Works Association who had given the matter considerable attention, that one of the functions of this society should be to accumulate a library of water works reports. I believe the Secretary now has in his possession a large number of reports from various cities, and it is desirable to have full and complete sets. It was thought that if permanent headquarters were obtained (and I am now speaking as a member of this association, and as one who has a strong interest in its success and welfare), we might have such a library, with a full and complete file of reports of all water works, as well as a collection of standard books on water works subjects, to which our members could have easy access at all times.

I might add that it was felt that the general nature of the work of the two associations was so similar that they could use the rooms jointly with advantage.

THE PRESIDENT. I don't want to take up too much time on this subject, but I consider it of vital importance, and it is something which ought to be put into such shape that it can be handled by your committee promptly and easily when the opportunity arrives in the negotiations with the Boston Society. Your Executive Committee assumed a certain amount of power which, perhaps, did not really belong to them, believing that this was a good time to secure headquarters, and that it was necessary to act promptly. After looking the ground all over we felt safe in making the offer we did to the Boston Society, trusting that you would approve our action. It should be clearly understood that the Boston Society were to lease the rooms, and sublet them to us, and we only agreed to take them for three years. That would call for an expenditure of $1,200 in the three years for rent.

We found we had something over $2,500 on hand at that time (it is about $2,600 now), and that the surplus of the present year is nearly $700. So we felt we would not be doing our duty to the association if we did not embrace this opportunity as it presented itself to secure headquarters for the association; for if, at the end of three years it should be found undesirable to continue the arrangement, we should have been amply repaid for our expendi-

ture by the experience we should have gained, and by the benefit we should surely have derived from the use of the rooms during that period, even if we did not want to continue the arrangement further. But as Mr. Noyes has said, the negotiations have not been carried on as rapidly as was expected, and no final action has been taken, and the association itself now has the opportunity to take action to authorize their committee to act for them in the matter, if they care to go on with it any further. Our position has been clearly stated to you, and we, believing that we acted for the best interests of the association, expected to come before you to-day asking you to endorse our action; but as the matter has not yet gone through, we now ask you, if you see fit, to authorize somebody to carry on the negotiations, so that the association, as a whole, will be responsible for them.

MR. COGGESHALL. There is one thought which has occurred to me which I will suggest for the benefit of our members. I take it for granted that the committee will make such provision that any member who happens to be in Boston can have access to these rooms during the daytime; and if there is any special matter in connection with water works subjects, on which he wishes information, he can consult the books in the library at any time.

MR. NOYES. Mr. President, perhaps I may be able to answer Mr. Coggeshall's question. Some three or four years ago this question of permanent headquarters was before the Boston Society of Civil Engineers. It was beyond their means, without increasing the dues beyond what was thought prudent, to obtain permanent headquarters, with a person in the employ of the society, in charge of the rooms. At that time one of the members of the association came forward and offered to pay part of the rental, to look after the library, to furnish a telephone, which the members could use as they needed, and also to keep the rooms open during the daytime. That arrangement has been carried out in a very satisfactory manner, and it has been a great success. It has been found desirable, however, to have larger quarters, so as to extend the usefulness of the society, and it has been suggested for some years that some similar arrangement might be made between the Boston Society and the New England Water Works Association with a third party, whereby suitable permanent headquarters might be obtained for both societies.

Now I do not consider that it would be within the means of either association, or of both of them, to employ a person to look after the libraries, and to keep the rooms open, which is certainly desirable, and I have no reason to doubt that the arrangement now proposed can be carried out in the same satisfactory manner as it has been done with the Boston Society alone during the last three or four years. The rooms can be used as a place for meeting by members of the association, the libraries would always be open for reference, and the members of this association would have access to the library of the Boston Society of Civil Engineers, which is quite extensive, and contains many books on scientific subjects in which members of this association are interested. The elevator will be run up to ten o'clock at night, and members who desire to visit the library in the evening can, undoubtedly, have keys. That has been the custom with the Boston Society, keys being furnished by the Secretary at cost. In that way access can be had in the evening, although otherwise the rooms are only open in the daytime.

THE PRESIDENT. Well, gentlemen, I hope you will express your minds freely in regard to this subject. Perhaps you may want to talk it over among yourselves a little, not having had a chance to do so, as much as you would like, and, therefore, with your permission, we will postpone the consideration of the matter for the present, and I will call it up at some later time during the convention. In the meantime, you can be thinking it over.

The President then called upon Mr. Crandall, Superintendent, Burlington, Vt., to read a paper on "The Water System of Burlington, Vermont." The paper was discussed by Messrs. Noyes, Williams, Gilbert, Fish and Hazen.

Prof. Storrs, of the University of Vermont, then read a paper on "Electrolysis." This was discussed by Messrs. Winslow, Gilbert, Fish, Chase, Haskell, Williams, Milne and Crandall.

AFTERNOON SESSION.

The Convention met promptly at 2.30 P. M.

Mr. John C. Haskell, Superintendent, Lynn, Mass., read a paper on "The Water Supply of Lynn."

John Thompson, Civil Engineer, New York, followed with a paper entitled, "Uniformity of methods in the bench-testing of

water meters, also comprising a few suggestions as to apparatus therefor, with tables of deliveries through small orifices of specified form under definite pressure." An interesting discussion followed the reading of the paper, participated in by Messrs. Haskell, Richards, McNally, Holden, Williams, Gilbert, Winthrop, Chase, Lockwood, Noyes, Hayes, the President and others.

EVENING SESSION.

At the evening session, at which there was a large attendance of members and ladies, and also of citizens of Burlington, Superintendent Crandall explained numerous stereopticon views of features of the Burlington water system. He was followed by Prof. Sedgwick of the Massachusetts Institute of Technology, who made an address, illustrated by the stereopticon, on "The Sanitary Condition of the Burlington Water Supply."

EVENING SESSION.

THURSDAY, September 12th.

Desmond FitzGerald, Superintendent of the Western Division Boston Water Works, gave "A Brief Description of the St. Louis Water Works," illustrated by the stereopticon.

The Secretary read a paper submitted by Clements Herschel, entitled, "Advisability of having tests of water meters, and of other articles of commerce, conducted by the association." The paper was discussed by Messrs. Cook, Noyes, Whitney, Thomas, Haskell, Smith, Richards and Prof. Swain.

MORNING SESSION.

FRIDAY, September 13th.

The first business was the election of officers. Mr. Haskell, for the Nominating Committee, made the following report:

Mr. President and Fellow Members: The committee appointed to nominate officers for the New England Water Works Association, for the ensuing year 1895–1896, have attended to their duty, and I now submit the names of the parties selected by them for your consideration.

PRESIDENT.

DESMOND FITZGERALD, Superintendent Western Division and Resident Engineer, Additional Supply, Boston Water Works, Brookline, Mass.

VICE PRESIDENTS.

H. T. SPARKS, Superintendent Water Department, Public Works Company, Bangor, Me.; CHARLES K. WALKER, Superintendent, Manchester, N. H.; F. H. CRANDALL, Superintendent and Treasurer, Burlington, Vt.; JOSEPH E. BEALS, Superintendent, Middleboro, Mass.; THOMAS MCKENZIE, Engineer, State Board of Health, Southington, Conn.; WILLARD KENT, Civil Engineer, Woonsocket, R. I.

SECRETARY.

J. C. WHITNEY, Water Registrar, West Newton, Mass.

TREASURER.

GEORGE E. BATCHELDER, Registrar, Worcester, Mass.

SENIOR EDITOR.

ALLEN HAZEN, Civil Engineer, Boston, Mass.

JUNIOR EDITOR.

WALTER H. RICHARDS, Civil Engineer, New London, Conn.

EXECUTIVE COMMITTEE.

JOHN C. HASKELL, Superintendent, Lynn, Mass.
HORACE G. HOLDEN, Superintendent, Nashua, N. H.
R. C. P. COGGESHALL, Superintendent, New Bedford, Mass.

FINANCE COMMITTEE.

A. R. HATHAWAY, Registrar, Springfield, Mass.
ARTHUR W. F. BROWN, Registrar, Fitchburg, Mass.
WILLIAM MCNALLY, Registrar, Marlboro, Mass.

Respectfully submitted for the committee:

JOHN C. HASKELL, *Chairman.*
HORACE G. HOLDEN,
FREEMAN C. COFFIN,
PATRICK KIERAN,
ALBERT F. NOYES.

On motion of Mr. Forbes, the Secretary was instructed to cast one ballot as the ballot of the association for the nominees recommended by the committee, and they were declared elected officers for the ensuing year.

MEMBERS ELECTED.

The Secretary read the following names of applicants for membership, duly approved and recommended by the Executive Committee.

RESIDENT ACTIVE.

James W. Graham, Supt. Meter Department, Portland Water Company, Portland, Maine; Henry Chandler, Manchester Water Board, Manchester, N. H.; J. M. Davis, Supt. Water Works, Rutland, Vt.; Joel Foster, Supt., Montpelier, Vt.; Fred B. Gleason, Foreman Water Department, Marlborough, Mass.

NON-RESIDENT ACTIVE.

Lemuel Amerman, Supt., Scranton, Pa.; W. F. P. Sealy, Potsdam Water Works, Potsdam, N. Y.

ASSOCIATE.

Massachusetts Chemical Company, South Boston.

On motion of Mr. Coggeshall, the Secretary was directed to cast the ballot of the association for the above named candidates for membership, and they were declared elected.

Charles K. Walker, Superintendent, Manchester, N. H., then read a paper entitled "A Short History of the Manchester High Service."

PLACE FOR NEXT ANNUAL CONVENTION.

Mr. Walker of Manchester extended a cordial invitation to the association to visit Manchester next year, or the year after, or at any time.

MR. NOYES. Mr. President, as this is a question which needs some little consideration, I would move that the selection of a place for the next annual convention be left in the hands of the Executive Committee, with full powers.

Adopted.

PERMANENT HEADQUARTERS.

THE PRESIDENT. As I said at the first session of this convention, there is a question pending with regard to headquarters for the association, and something definite ought to be done about it. I therefore wait any motion or action that the Convention sees fit to take in the matter.

MR. COGGESHALL. I move that the Chair give full liberty to any of the associate members present to enter into this discussion, as we would like to have their views upon this subject, and to hear the question presented from their standpoint.

Adopted.

THE PRESIDENT. I await any motion in regard to the subject of permanent headquarters for this association.

MR. FORBES. I am personally in favor of securing permanent headquarters, but I think that there are many who would not wish to do so unless it could be done without increasing the annual dues. It would seem to me that the better way would be to leave the whole matter to the Executive Committee, with full powers, but with this suggestion: that no action be taken towards securing permanent headquarters unless it can be done without increasing the annual dues, and I move that the whole matter be referred to the Executive Committee, with full powers, with the exception that no expense be created which cannot be met by the annual dues as now paid by the members.

THE PRESIDENT. Do you wish to limit them as to time?

MR. FORBES. No; I would give them unlimited time and powers, with the exception of not increasing the dues of the members.

The motion was seconded by Mr. Williams.

THE PRESIDENT. I would say that as far as our negotiations were carried, the arrangements proposed could be made without increasing the dues, or embarrassing us at all in our finances.

MR. CODD. Permanent headquarters would, of course, benefit more directly those members who are in the habit of going to Boston frequently, but I should not object to carrying out the scheme proposed, at almost any cost, even if it increased our dues. There is nothing for which we pay two dollars from which we get so much return as we do from this association.

THE PRESIDENT. Is there anything to be said by any member on this motion?

MR. GILBERT. I fear that perhaps this matter is not thoroughly understood by everyone so that they can vote intelligently upon it. Leaving this matter with the Executive Committee, with full powers, might be leaving it in a way that will result in some feeling among members of the association, and I suggest that it might be well to have the matter once more fully explained before we vote.

THE PRESIDENT. I would say that all negotiations up to this point have been conducted by the Executive Committee which will go out of existence to-day. The matter came up at a time when it was impossible for us, without considerable expense and inconvenience, to call a special meeting of the association. The Boston Society of Civil Engineers have a room which they occupy at the present time, which room they have found too small for them. An associate member of our association has desk room there, and his stenographer has charge of the library, and keeps the room in order, and keeps it open to members of the Boston Society during the day; and with that arrangement the Boston Society was able to meet the expense of having headquarters. It was, at first, an experiment with them, as it is with us to-day. The experiment has been so satisfactory that they are looking now for increased accommodations. In looking over the matter they found that adequate accommodations for all of their requirements would involve expenses greater than they could well pay, although their dues are more than double ours, and they will probably be still further raised. Now, they thought that if they could get the New England Water Works Association to go in with them or sublet from them a part of the room they might secure, they would then have quarters which would be better adapted to the requirements of their evening meetings. The blue print plan of the new Tremont Temple building in Boston showed three rooms which could be thrown together, and they proposed to make an arrangement with the party they have had in their present quarters, to take charge of the rooms and to pay a part of the rent, the same as formerly, except that the party taking charge of them will be in a room entirely separate from the other rooms of the society, but with a door between the office of the firm and rooms of the society. They cannot afford quarters which would be adequate for their purposes without making some such arrangement, and if the Water Works Association withdraws the proposition now pending, and do not make any arrangements with them, the Boston Society still proposes to have new quarters, although they will have to be smaller than those which have been contemplated. They proposed to the New England Water Works Association, that we, being a kindred organization, closely allied in our work with them, should sublet from them the right to use a part of the space exclusively for our library, for which we ought to

have had some accommodation years ago, for we could easily accumulate a valuable library if we had a place where we could keep our books, and file away our documents. A part of the wall space would be set aside exclusively for our library, but the whole room would be used in common by the two societies.

The proposition we made to the Boston society was that we would pay $400 a year, they leasing the property and subletting it to us. That was to be the whole expense to us, including light, heat, and janitor service, and the offer was for three years only. And it was also provided that no other society should occupy the premises without the consent of both organizations.

Since then, owing to some misunderstanding in regard to the exact sizes of the rooms, the negotiations have been delayed and are still pending. Now, the Executive Committee chosen to-day can take this matter up and carry it forward if you wish, or you can kill the whole question of headquarters for this association by letting it drop where it is. What is best for the association, and what is fair for all parties is for you to decide now. If you have an Executive Committee in which you have confidence, you may refer this matter to it with full powers, or you may take any other action you see fit. The good of the association as a whole is what we are all striving for, and I think I need say no more on the subject. I have given you as clear an explanation as I can of what has occurred up to this time.

I may add, for the benefit of the new members who, perhaps, do not know about it, that three or four years ago, when we had our convention in Hartford, this matter of headquarters was brought up, and some of our progressive members, who are pushing ahead all the time, thought the association should have headquarters, and at that time a committee was appointed to look into the matter. But no opportunity presented itself for obtaining headquarters, within the means of the association, until this last Summer, when it looked as though there was a chance.

Is there anything to be said upon the motion before the house, that the whole matter be left to the Executive Committee with full powers to act, with the limitation that the expense shall not be such as to increase our annual dues?

MR. BEALS. I think, in the report made day before yesterday, there was a point mentioned that you have not brought out today,

Mr. President. I understand that the Boston Society has accumulated, and is accumulating, a very valuable library, and that under this proposed arrangement the members of the New England Water Works Association will have the right to use that library, as well the library that we may gather ourselves. This would be of material value to us, because if we are seeking information, and could not find it in our library, we might, perhaps, find it in the library in the adjoining room, if we make this arrangement with the Boston Society.

THE PRESIDENT. In our talk with the Boston Society it was understood that our members should have free access to its library, which is a very extensive and valuable one. Is there anything more to be said? We are in a hurry, but we have time enough to discuss this as long as anybody wants to talk upon it, if we don't do anything else to-day. We would be glad to hear from any member.

MR. SIDNEY SMITH. I hope that the association will express confidence in its new Executive Committee, and leave this matter entirely in their hands. It is a matter which has been before the Boston Society of Civil Engineers for a great many years. It is something which requires prompt action when the time comes.

MR. G. S. WILLIAMS. It appears to me that the real question, or the question over which there may possibly be a desire to have a discussion, has not been brought before the association yet in a way to permit of its formal discussion. I think that there is not a member of the association that is not desirous of having a permanent home for the association; at the same time the question seems to be as to whether the scheme which has been proposed is a desirable one. I understand that there have been some objections raised to it. In order to bring the question before the association, and in order that the doings of the Executive Committee, now going out of office, may be either indorsed or objected to, I move as an amendment to Mr. Forbes' motion that the association indorse the action that has been thus far taken by the Executive Committee.

MR. NOYES. Mr. President, I have refrained from speaking on this question, having spoken somewhat at length upon it the other day, but it seems to me, while I feel it to be very fitting that the action of the old Executive Committee should be approved, that the hands of the new Executive Committee should be left untied, for

the reason that some questions may come up on which it would wish to take a different action from that taken by the old Executive Committee. There has been some slight objection raised to the plan proposed, and it seems to me the new Executive Committee might, perhaps, act more deliberately and wisely if they were not hampered by any vote which it might construe as calling upon it to act directly in accordance with the action of its predecessor.

THE PRESIDENT. The motion before the house is, that the whole matter be left in the hands of the Executive Committee, with full powers to act, with the exception that the expense to the members shall not be increased. Mr. Williams' motion is in the form of an amendment, that the association indorse the action of the Executive Committee of last year.

MR. NOYES. Is it to be understood, Mr. President, that our indorsement of the action thus far taken will make it necessary for the new Executive Committee to confine itself entirely to carrying out what has already been begun?

MR. WILLIAMS. That certainly was not my intention in making the motion.

MR. NOYES. Then, of course, I will withdraw my objection to the amendment.

THE PRESIDENT. Let us understand this thoroughly. The Executive Committee, perhaps, exceeded its powers in negotiating in any manner for headquarters; but believing it was for the interest of the association that some action should be taken, and as it looked at the time as though we had got to take the matter in hand at once or lose the opportunity, we took the course that we did. If the plan had gone through, and the Boston Society had accepted the proposition we made in your behalf, we should have come before you for your indorsement to-day. So I understand that the vote now proposed, our action having been a little informal up to this point in our negotiations, is merely meant as an indorsement of the action of the committee in doing what it considered to be its duty.

Mr. Williams' amendment was adopted.

THE PRESIDENT. I thank you, gentlemen, for indorsing our action; it relieves our consciences and clears up the matter so that there is nothing obscure, and we are much obliged to Mr. Williams for seeing that point.

Now the motion before the house is that the question of head-

quarters be left to the Executive Committee with full powers to act, with the one exception of increasing the dues. Is there any other member here who wishes to speak on that question? If not, I shall put it to vote.

Mr. Forbes' motion, leaving the matter to the Executive Committee with full powers, except that the annual dues of the members must not be increased, was then unanimously adopted.

Mr. R. H. Cairns, City Engineer, Waterbury, Conn., presented and explained a series of stereopticon "Views of the New Works at Waterbury."

Mr. George H. Barrus, Civil Engineer, Boston, read a paper on "Calorific Determination of the Value of Fuel," illustrated by the use of his apparatus. The paper was discussed by Messrs. Williams, Coggeshall, Noyes, Holden, Whitney and Smith.

Mayor Van Patten, of Burlington, sent for distribution among the members an illustrated pamphlet on the city of Burlington.

On motion of Mr. Chase, a vote was passed extending the thanks of the association to His Honor, and also expressing regret at his inability to be present.

The Secretary read a paper by R. C. Bacot, Jr., Superintendent Meter Department, Port Chester, N. Y., on "Attaching and Care of Water Meters."

The convention then adjourned.

EVENING SESSION.

Albert F. Noyes, Civil Engineer, member of the Massachusetts Sewerage Commission, made an address on "The Metropolitan Water Supply of Massachusetts."

CLOSING COURTESIES.

MR. COGGESHALL. I have a number of resolutions I would like to introduce at this stage of the proceedings. And first, I move:

"That the sincere thanks of the members of this association be extended to the citizens of Burlington; R. D. Wood & Co., of Philadelphia; the Chapman Valve Manufacturing Co., of Indian Orchard, Mass.; the Hersey Manufacturing Co., of Boston, Mass., and the Thomson Meter Co., of New York, for the beautiful entertainment provided by them, and which has done much to contribute to the success of the convention."

MR. NOYES. In seconding this motion I wish to express the

gratitude which I feel, and which I know all of the members of this association feel, for the hospitality and kindness which have been extended to them here, and the pleasure which they have experienced in accepting it. We were told some years ago, when a very cordial invitation was extended to us to come to Burlington, that we should have a good time if we came, and a profitable convention. It was thought, at that time, that Burlington was almost too far away for the convenience of our members. I do not believe that we shall ever look upon Burlington again as much farther away than our own hearthstones. I most cordially second the resolution submitted by Mr. Coggeshall.

The President called upon those who favored the resolution to manifest it by raising both hands, and declared the vote to be "a doubly unanimous vote, something which never occurred before in the history of the association."

MR. COGGESHALL. I further move "That the thanks of the members of this association are hereby extended to the National Meter Company of New York for the excursion provided, on Wednesday last, for the ladies attending this convention."

The President ruled that on this motion the ladies could vote, and the motion was adopted.

Mr. COGGESHALL. I also move "That the sincere thanks of the members of this association be extended to Messrs. F. H. Crandall and W. H. Lang, both of Burlington, for the large amount of work done by them to make the programme of this convention a success; also that thanks be hereby extended to Mrs. W. E. Hall for the beautiful flowers contributed and placed in the convention hall during the various sessions."

Adopted.

MR. COGGESHALL. And, now, Mr. President, we all know we have had a beautiful time here. This association was organized in 1882, and its first convention was held in Boston. The following year we went to Worcester, then to Lowell, then to Springfield, then to New Bedford, next to Manchester, from Manchester to Providence, from Providence to Fall River, from Fall River to Portland, from Portland to Hartford, from Hartford to Holyoke, from Holyoke to Worcester, from Worcester to Boston, and from Boston we have come here; and in the whole history of this association, I do not think we ever had a finer convention, or a more successful

one, than this has been. And one member of this association, more than any other, should have the credit of the success of our present convention. He is a member for whom we have a large amount of love and esteem, and I have been directed by my fellow members to hand these books to our esteemed friend and associate, Mr. Crandall, as a slight token of the love and respect with which he is regarded by us all. [Applause.]

MR. CRANDALL. Mr. President, and Gentlemen of the New England Water Works Association, I cannot express fittingly my feelings at receiving this testimonial of your regard. I can only say that if this meeting has been successful and pleasant, it is my delight that it has been so, and that in some small measure I have, perhaps, been able to contribute to the profit and pleasure of you all. [Applause.]

MR. COGGESHALL. Now, Mr. President, I am going to make a motion, which I shall ask our Secretary to put, that the sincere thanks of the members of this association be extended to our retiring President, Mr. George A. Stacy, for the able and courteous manner in which he has presided over the business and deliberations of this association.

The motion was adopted by the members rising.

MR. STACY. Gentlemen of the New England Water Works Association, and Ladies, for as I understand, there is soon to be another association for our ladies, during the term of office with which you have honored me, and which I have held, under circumstances that were beyond our control, for a year and three months, there has been up to the present moment only one cause for regret on my part, and that I now experience, owing to the fact that your President elect is not here, and that I cannot have the pleasure of presenting him to you. As he is not here personally, I am not able to speak fittingly for him, but he is known to you as a man who is eminent in his profession, who has long been an interested and active member of this association, and is a man who would be a credit, either as a member or an officer, to any association in the world. I heartily commend your judgment in the selection you have made.

And now, as I am about to lay down the gavel for the last time, I want to extend to you the thanks, which I feel are due to you, for the very able and kindly manner in which you have supported me

throughout the year and three months in which I have held this office, and which has made possible the holding of this convention, which has been the grandest ever held by our association. I want to thank you for your work to-day. I do not think I ever attended a convention in which the members kept at their work so well, and did so much, especially when we consider the great attractions outside to draw them away to visit the beautiful surroundings with which this place is favored. Our records, I think, will show that we have done as much, if not more, business than at any other convention we have ever held. Now, in leaving my office, and laying down the responsibility and work, I do it with a deep sense of obligation to you for your support and interest. I only ask of you, in behalf of the President elect, that you will give him the same support that you have given me and to your other presidents, and if you do that the success and prosperity of the New England Water Works Association is assured. I thank you all again for your attendance here, and your attention, and express the hope that we shall all work together harmoniously in the future as we have in the past.

Is there any other business to come before the association at this time?

MR. COGGESHALL. I move that the thanks of this association be extended to our Secretary, Mr. Whitney, for the conscientious and able manner in which he has attended to the duties of his office.

THE PRESIDENT. It is with great pleasure I put that motion expressing our appreciation of the man who is the sheet anchor of this association. Adopted.

THE PRESIDENT. Now, Mr. Whitney, a speech. [Applause.]

MR. WHITNEY. Mr. President, I think I understand what the applause means; it means you only want a very few words from me. I certainly thank the members for their very kind reception, and I feel that I owe very much more to them than they do to me.

MR. CHACE. I move the thanks of this association be given to the retiring senior editor, Dexter Brackett, for his services. Adopted.

On motion of Mr. Richards, the convention adjourned.

SOCIAL FEATURES.

The social features of the convention were unusually interesting and varied.

On Wednesday, by invitation of the National Meter Company, the ladies of the party enjoyed an excursion on the steamer down the lake to Fort Ticonderoga and return and dinner on the steamer.

On Thursday, through the courtesy of the citizens of Burlington, R. D. Wood & Co., the Chapman Valve Manufacturing Company, the Thomson Meter Company, and the Hersey Meter Company, members and guests numbering 180 were treated to a trip through the Ausable Chasm and dinner at the Hotel Champlain. The party proceeded across the lake to Port Kent, where cars were taken to the chasm. Several hours were spent in viewing the inspiring scenery of the chasm and a boat ride down the rapids, during which several members received an involuntary shower bath, after which the party were conveyed by carriage and rail to the magnificent Hotel Champlain. After dinner the return was made by steamer to Burlington.

On Friday afternoon a trip was made on special trolley cars to Fort Ethan Allen. There the operation of an air lift pump was inspected. The pump which is used to supply the U. S. government barracks takes water from two wells of 6-inch and 8-inch diameter, and over 300 feet deep. The water is lifted, by the air lift pump, at the rate of 5,000 gallons per hour, from a depth of about 140 feet to the surface, after which it is raised by a steam pump to a stand-pipe 85 feet high.

From the pump attention was turned to the cavalry post which was inspected in all its details. Lieut. Tate kindly brought out a squad from Troop F, that went through the Cossack drill. After witnessing dress parade the party returned to the city.

Most of the party departed by the morning trains on Saturday; all with pleasant memories of "Beautiful Burlington" and its hospitable citizens.

LIST OF EXHIBITS BY ASSOCIATE MEMBERS AT THE CONVENTION.

UNDER CHARGE OF W. H. LANG.

Chapman Valve Mfg. Co., Indian Orchard, Mass., Valves and Hydrants.

Crosby Steam Gage and Valve Co., Boston, Mass., Gages and Valves.

Hersey Mfg. Co., South Boston, Mass., Meters.

Lead Lined Iron Pipe Co., Wakefield, Mass., Service Pipe and Fittings.

Lang, Goodhue Co., Burlington, Vt., Flexible Pipe Joint.

H. Mueller Mfg. Co., Decatur, Ill., Brass Goods and Tapping Machines.

National Meter Co., New York, Meters.

Neptune Meter Co., New York, Meters.

Peet Valve Co., Boston, Mass., Valves.

Pittsburg Meter Co., Pittsburg, Pa., Meters.

Ross Valve Co., Troy, N. Y., Valves.

Anthony P. Smith, Newark, N. J., Main Pipe Tapping Machine.

Benj. C. Smith, New York, Cast Iron Pipe Cutting Machine.

Thomson Meter Co., Brooklyn, N. Y., Meters.

Union Water Meter Co., Worcester, Mass., Meters.

Walworth Mfg. Co., Pipe Cutters, Tapping Machines and Brass Goods.

H. R. Worthington, New York, Meters.

R. D. Wood & Co., Philadelphia, Pa., Drawings of Hydrants.

ATTENDANCE AT THE CONVENTION.

ACTIVE MEMBERS.

Abbott, E. L., Brookline, Mass.
Amerman, Lemuel, Scranton, Pa.
Baldwin, Chas. H., Boston, Mass.
Bancroft, Lewis M., Reading, Mass.
Barrus, George H., Boston, Mass.
Batchelder, G. E., Worcester, Mass.
Beals, Joseph E., Middleboro, Mass.
Bigelow, James F., Marlboro, Mass.
Bisbee, F. E., Auburn, Me.
Burke, James E., Princeton, N. J.
Cairns, R. A., Waterbury, Conn.
Chace, George F., Taunton, Mass.
Chadbourne, E. J., Wakefield, Mass.
Chandler, Henry, Manchester, N. H.
Chase, John C., Wilmington, N. C.
Codd, W. F., Nantucket, Mass.
Coggeshall, R. C. P., New Bedford, Mass.
Cook, Byron I., Woonsocket, R. I.
Crandall, F. H., Burlington, Vt.
Crandall, George K., New London, Conn.
Crowell, George E., Brattleboro, Vt.
Davis, J. M., Rutland, Vt.
Dotten, W. T., Winchester, Mass.
Drake, B. F., Laconia, N. H.
Dyer, E. R., Portland, Me.
Eastman, H. E., Westport, N. Y.
Fish, J. B., Scranton, Pa.
FitzGerald, Desmond, Boston, Mass.
Forbes, F. F., Brookline, Mass.
Foster, Joel, Monpelier, Vt.
Gilbert, J. C., Whitman, Mass.
Gilderson, D. H., Bradford, Mass.
Giles, Jason, Indian Orchard, Mass.
Gleason, Fred. B., Marlboro, Mass.
Glover, Albert S., Boston, Mass.
Gow, Fred. W., Medford, Mass.
Graham, J. W., Portland, Me.
Greene, S. C., St. Albans, Vt.
Hammatt, E. A. W., Boston, Mass.
Harrington, George W., Wakefield, Mass.
Haskell, John C., Lynn, Mass.

Hastings, V. C., Concord, N. H.
Hazen, Allen, Boston, Mass.
Hayes, A. G., Middleboro, Mass.
Holden, H. G., Nashua, N. H
Huntington, James A., Haverhill, Mass.
Hyde, H. N., Newton, Mass.
Jones, J. A., Stoneham, Mass.
Kempton, David B., New Bedford, Mass.
Kent, E. W.,, Woonsocket, R. I.
Kent, Willard, Narragansett Pier, R. I.
Kieran, Patrick, Fall River, Mass.
Knowles, Morris, Boston, Mass.
Locke, James W., Brockton, Mass.
Lockwood, Joseph A., Yonkers, N. Y.
McIntosh, H. M., Burlington, Vt.
McNally, William, Marlboro, Mass.
Nash, H. A., Jr., Boston, Mass.
Naylor, Thomas, Maynard, Mass.
Northrop, F. L., Milford, Mass.
Noyes, Albert F., Boston, Mass.
Parks, Charles F., Boston, Mass.
Rice, J. L., Claremont, N. H.
Richards, W. H., New London, Ct.
Ries, George J., Weymouth, Mass.
Rogers, H. W., Haverhill, Mass.
Russell, Daniel, Everett, Mass.
Salisbury, A. H., Lawrence, Mass.
Sanborn, Willard T., Dover, N. H.
Sealy, W. F. P., Potsdam, N. Y.
Sedgwick, W. T., Boston, Mass.
Shepard, F. J., Derry, N. H.
Smith, H. O., Leicester, Mass.
Smith, Sidney, Rutland, Vt.
Stacy, Geo. A., Marlboro, Mass.
Stoddard, S. G., Jr., Bridgeport, Ct.
Swain, Geo. F., Boston, Mass.
Tenney, J. G., Leominster, Mass.
Thomson, John, New York, N. Y.
Thomas, R. J., Lowell, Mass.
Thomas, W. H., Hingham, Mass.
Wallace, E. L., Franklin, N. H.
Walker, Chas. K., Manchester, N. H.
Warren, H. A , St. Albans, Vt.
Watters, Joseph, Fall River, Mass.
Welch, J. Alfred, Methuen, Mass.
Whitney, J. C., Newton, Mass.
Whittemore, W. P., No. Attleboro, Mass.
Williams, G. S., Detroit, Mich.
Winslow, George E., Waltham, Mass.
Zick, W. G., Brooklyn, N. Y.

Total active membership present, 91.

HONORARY MEMBERS.

The Engineering News, of New York City, by M. N. Baker.
The Engineering Record, of New York City, by Charles J. Underwood, Jr.
Fire and Water, of New York City, by F. W. Shepperd.

Total honorary membership present, 3.

ASSOCIATE MEMBERS.

Chadwick Lead Works, Boston, Mass., by A. H. Brodrick.
Chapman Valve Co., Indian Orchard, Mass., by E. L. Ross.
Deane Steam Pump Co., Holyoke, Mass., by Chas. P. Deane, F. H. Hayes and J. E. Bachelder.
Hersey Mfg. Co., Boston, Mass., by J. E. Spofford and Jas. A. Tilden.
Ingersoll-Sergeant Co., Boston, Mass., by M. S. Harlow.
Lang & Goodhue Co., Burlington, Vt., by W. H. Lang.
McNeal Pipe and Foundry Co., Burlington, N. J., by Wilmer Reed.
Mass. Chemical Co., Boston, Mass., by A. R. Baldwin.
Chas. Millar & Co., Utica, N. Y., by F. D. Fisk.
Mueller Mfg. Co., Decatur, Ill., by Adolph Mueller and A. H. Barber.

National Meter Co., New York City, N. Y., by J. G. Lufkin.
Peet Valve Co., Boston, Mass., by S. B. Adams.
Pittsburg Meter Co., Pittsburg, Penn., by A. L. McKaig.
Ross Valve Co., Troy, N. Y., by Wm. Ross, Secretary.
Anthony P. Smith, Newark, N. J., by W. H. Van Winkle,
Benj. C. Smith, New York City, N. Y., by Fred. A. Smith.
Thomson Meter Co., Brooklyn, N. Y., by Henry C. Folger.
Union Meter Co., Worcester, Mass., by John C. Otis and J. P. K. Otis.
Walworth Mfg. Co., Boston, Mass., by J. H. Eustis and B. Frank Polsey.
R. D. Wood & Co., Philadelphia, Penn., by Jesse Garrett and J. H. Marshall.
Henry R. Worthington, New York City, by J. M. Betton and Geo. B. Ferguson.

Total associate membership present, 29.

GUESTS.

Abbott, E. L. Mrs., Brookline, Mass.
Ammerman, L. Mrs., Scranton, Pa.
Baker, M. N. Mrs., New York City.
Bancroft, Louis M. Mrs., Reading, Mass.
Barrows, John H., New Bedford, Mass.
Barrows, John H. Mrs., New Bedford, Mass.
Batchelder, G. W., Worcester, Mass.
Batchelder, F. R. Mrs., Worcester, Mass.
Beals, Joseph E. Mrs., Middleboro, Mass.
Brightman, Charles P., Fall River, Mass.
Brown, N. K., Burlington, Vt.
Catlin, Fred. J., Flint, Mich.
Chace, G. F. Mrs., Taunton, Mass.
Chase, Fred. A., Providence, R. I.
Chase, Helen G. Miss., Providence, R. I.
Chase, J. C. Mrs., Wilmington, N. C.
Coggeshall, R. C. P. Mrs., New Bedford, Mass.
Crandall, F. H. Mrs., Burlington, Vt.
Crandall, George K. Mrs., New London, Conn.
Creighton, C. Mrs., Fall River, Mass.
Davis, Mrs., St. Albans, Vt.
Dwyer, Thomas E., Wakefield, Mass.
Evans, J. M., Burlington, Vt.
Fish, J. B. Mrs., Scranton, Pa.
Forbes, F. F. Mrs., Brookline, Mass.
Giles, Jason Mrs., Indian Orchard, Mass.
Hall, W. E., Burlington, Vt.
Holden, H. G. Mrs., Nashua, N. H.
Hope, B. B., Middlesex, Vt.
Kempton, David B. Mrs., New Bedford, Mass.
Kent, E. W. Mrs., Woonsocket, R. I.
Kent, Willard Mrs., Narragansett Pier, R. I.
Lang, George L., Burlington, Vt.
Lang, W. H. Mrs., Burlington, Vt.
Langworthy, A. H., Middlesex, Vt.
Macain, George, Milford, Mass.
McNally, William Mrs., Marlboro, Mass.
Mann, George E., Woodsville, N. H.
Marvin, Charles, Worcester, Mass.
Milne, Peter, Brooklyn, N. Y.
Nash, Miss, Boston, Mass.
Naylor, Thomas Mrs., Maynard, Mass.
Parks, C. F. Mrs., Boston, Mass.
Parks, Louise S. Miss, Boston, Mass.
Prescott, S. C., Boston, Mass.
Reed, Wilmer Mrs., Burlington, N. J.
Richards, W. H. Mrs., New London, Conn.

Ries, George J. Mrs., Weymouth, Mass.
Rogers, H. W. Mrs., Lawrence, Mass.
Ross, E. L. Mrs., Indian Orchard, Mass.
Salisbury, A. H. Mrs., Lawrence, Mass.
Sanborn, W. T. Mrs., Dover, N. H.
Sanctuary, E. N. Burlington, Vt.
Sawyer, H. T. Medford, Mass.
Shepard, F. J. Mrs., Derry, N. H.
Small, S. J. Miss, New Bedford, Mass.
Smith, H. O. Mrs., Leicester, Mass.
Spofford, J. E. Mrs., Boston, Mass.
Stacy, George A. Mrs., Marlboro, Mass.
Storrs, H. A. Burlington, Vt.
Sullivan, William F. Mrs., Dover, N. H.
Swain, George F. Mrs., Boston, Mass.
Temney, J. G. Mrs., Leominster, Mass.
Thomas, H. L., Hingham, Mass.
Wallace, E. L. Mrs., Franklin, N. H.
Walling, W. H., Potsdam, N. Y.
Warren, H. A. Mrs., St. Albans, Vt.
Watters, Joseph Mrs., Fall River, Mass.

Total number of guests, 68.
Total attendance registered, 191.

ELECTROLYSIS.

BY

PROFESSOR H. A. STORRS, University Vermont, Burlington, Vt.

[Read Sept. 11th, 1895.]

Members of the New England Water Works Association, Ladies and Gentlemen:

When I consented last June, to present a paper at this meeting, I was planning a series of experiments which I hoped would add some interesting facts to those already known in regard to the electrolysis of underground pipes by return currents from electric railways. But a serious accident to my eyes in July upset my plans; so that what I now have to offer is simply a brief statement of some practical information on the subject, gleaned from technical publications during the past year or two, and including some hints which I trust will prove of practical value to practical men.

I have selected three heads under which to group the remarks I have to make in regard to the destructive action of electric currents on underground pipes.

First. Remedies in the case of cities where electric roads are already in operation.

Second. Preventive measures for cities where roads are yet to be installed.

Third. Some of the legal aspects of the subject.

With few exceptions the electric roads now operating in this country use the "single trolley system." The overhead wires, including trolley wires and feeders, form one side of the circuit; the rails, the earth, conductors called "return feeders," and too often water and gas pipes constitute the other side of the circuit, the two being connected through the cars in operation. On roads of this kind the positive side of the generator should be connected to the overhead system of conductors. The current then flows from the

generator through the feeders to the trolley wire, thence down the trolley pole through the motors and trucks to the rails, thence back to the negative side of the generator by any and every path available. Now to prevent the current from returning by way of the pipes we must render it impossible for them to become easily available paths. The most easily available path is, of course, the one of greatest conductivity. If rails are properly bonded from end to end of the track and the track connected to the negative side of the generator by a wire of proper conductivity, a very large part of the electricity used by the car motors will avail itself of this easy path back to the generator. But if a considerable quantity of electricity still chooses to avail itself of the underground pipes, then additional paths must be provided in the shape of large copper wires, called the return feeders. These are attached at frequent intervals to the rails and are carried, either underground or overhead, back to the negative side of the generator. These form additional paths of high conductivity and are, therefore, easily available for the return currents.

But even when a goodly number of return paths have been thus provided the electric currents still choose, with that perversity we ascribe to inanimate things, to avail themselves in a measure of the pipes which lead in the direction in which they tend to flow. If we examine this path back to the generator, by way of the pipes, we find that the electricity must first pass from the rails through a stratum of moist earth in order to reach the pipes, then pass along the pipes as far as they offer an available path, then leave the pipes, and pass again through a stratum of moist earth back to the rails, return feeders or other conductors and eventually reach the negative side of the generator.

This stratum of earth is of relatively low conductivity and when dry renders the return path, by way of the pipes, almost unavailable for the return current. Even when moist it offers considerable resistance to the electric current and to that extent acts as a shield to the pipes, tending to prevent electricity from leaking to them. And since we desire so far as possible, to prevent electricity from getting to the pipes, we must ascertain where the localities are at which electricity tends to leak from the rails to the pipes and there preserve our shield of earth intact. Evidently to connect the rails to the pipes by means of wires in these localities is just what ought not to be done.

Yet this has been done in numberless cases and much mischief has been done thereby. Railway companies have bonded their tracks to pipes for the purpose of using the latter as an aid to their ground return. In this way enough electricity has sometimes been caused to flow through a pipe line to set fire to the oakum which workmen were using in caulking a joint. Metallic connections are also sometimes made accidentally from track to pipes by service pipes being permitted to touch some portion of the tracks. Water and gas pipes have sometimes been indiscriminately bonded to tracks under the mistaken notion that injury to pipes would be prevented thereby.

The general rule may be laid down that where electricity tends to pass from the track to the pipes, or, technically speaking, where the track is "positive to the pipe," or where the track is of "higher potential than the pipes," there metallic connections should be avoided; our first aim being to keep the pipes out of reach of electrical currents so far as possible. It therefore becomes necessary to ascertain the localities in which tracks are "positive to pipes." For this purpose a voltmeter, reading to hundreths of a volt, is required, and where pipes are not accessible, tests between the rails and fire hydrants may be relied upon to give reasonably accurate results.

In spite of all precautions, however, there will generally be sufficient leakage from the track to the pipes to cause trouble. For any electricity that has found its way into the pipes must also find its way out, and if no better path is available it will pass out of them into the moist earth around them. Wherever this occurs electrolytic action will result; for the earth found under city streets is usually impregnated with water holding in solution salts of the alkaline earths which are easily decomposed by electricity. Now one of the products of this electrolysis is an acid radical which combines with the iron of the pipe from which the current is flowing and forms a ferrous salt. This ferrous salt diffuses through the damp soil thus carrying away iron from the pipes and eventually destroying them. The electrolysis of water requires a difference of potential of about one and a half volts. But electrolysis of such salts as are common in the soil of city streets, has been found to take place where the measured difference of potential was only one thousandth of a volt†, showing that a mere "directive force" is sufficient to cause the action.

†Trans. Am. Inst. Elec. Eng. Vol. XI., p. 237.

But electrolytic action will not occur if the electricity leaves the pipe by a metallic path. Therefore, having ascertained by the aid of a volt-meter the localities where electricity tends to leave the pipe—that is, where pipes are positive to the surrounding earth and neighboring conductors, we proceed to attach to them special return feeders of sufficient size to easily carry back to the generator all the electricity flowing in the pipes.

Having thus outlined the theory and practice of dealing with this danger to underground pipes, I will quote from a paper* of Mr. I. H. Farnham, to whom belongs the honor of having first described and applied this method of protecting pipes from electrolytic action, the conclusions he arrived at as a result of his careful series of experiments:

"First. All single trolley railways employing the rails as a portion of the circuit, cause electrolytic action and consequent corrosion of the pipes in their immediate vicinity, unless special provision is made to prevent it.

"Second. A fraction of a volt difference of potential between pipes and the moist earth surrounding them, is sufficient to induce the action.

"Third. Bonding the rails, or providing a metallic return conductor equal in sectional area and conductivity to the outgoing wires, is insufficient to wholly prevent damage to pipes.

"Fourth. Insulating pipes sufficiently to prevent the trouble is impracticable.

"Fifth. Breaking the metallic continuity of pipes at sufficiently frequent intervals is impracticable.

"Sixth. It is advisable to connect the positive pole of the dynamo to the trolley lines.

"Seventh. A large conductor, extending from the grounded side of the dynamo entirely through the danger territory, and connected at every few hundred feet to such pipes as are in danger, will, usually, ensure their protection.

"Eighth. It is better to use a separate conductor for each set of pipes to be protected.

"Ninth. Connection only at the power station to water or gas pipes will not ensure their safety.

"Tenth. Connection between the pipes and rails, or rail-return wires outside the danger district, should be carefully avoided.

*Trans. Am. Inst. Elec. Eng., Vol. XI., p. 191.

"Eleventh. Frequent voltage measurements between pipes and earth should be obtained, and such changes in return conductors made as the measurements indicate."

Referring to conclusion fifth, it is often found that at pipe joints, where metallic continuity has been accidentally interrupted, intense electrolytic action has occurred.

Referring to conclusions seventh and tenth, the "danger territory" includes all the territory wherein the pipes are positive to the surrounding earth. In cities containing but one power station, the danger territory is usually confined to the immediate vicinity of the station, its area depending upon the extent to which the tracks are properly bonded and return feeders installed.

So much depends upon having good electrical contact between the pipes and the return feeders, that I present a sketch (Fig 1.) of the clamp for attaching a wire to a water main, devised by Mr. M. G. Starrett, chief electrician of the Brooklyn city railway, and thus described*: "The collar is of wrought iron, in two parts, $\frac{5}{8}$ of an inch thick, and two inches broad. The two parts are drawn together by $\frac{3}{4}$ inch bolts, with two nuts to each bolt. The collar is previously turned out upon its inner face to $\frac{1}{4}$ of an inch larger diameter than that of the pipe to which it is to be applied. Midway in one part is formed a lug, into which is brazed a No. 00 copper wire. In applying the connection the pipe is carefully brightened all around with a file. A strip of bright lead $\frac{5}{32}$ of an inch thick and $2\frac{1}{2}$ inches broad, is laid around the pipe, and the collar is clamped down by the bolts until the lead gasket is meshed into the inequalities of the pipe. The lines of juncture between the collar and lead and pipe are thickly painted over with "P. & B." mixture, then carefully taped over and again painted with "P. & B." upon the tape, after which the whole is thoroughly packed in with good cement." The thoroughness of this method is not deemed excessive, in view of the requirements of the case, since the efficacy of this remedy for electrolytic action depends largely on maintaining good electrical contact here. Where cast iron pipes are used, reliable connection may be obtained by tapping a $\frac{3}{4}$ inch hole and inserting a brass plug, to which the copper return wire may be thoroughly soldered.

*Electrical World, Vol. 25, p. 72.

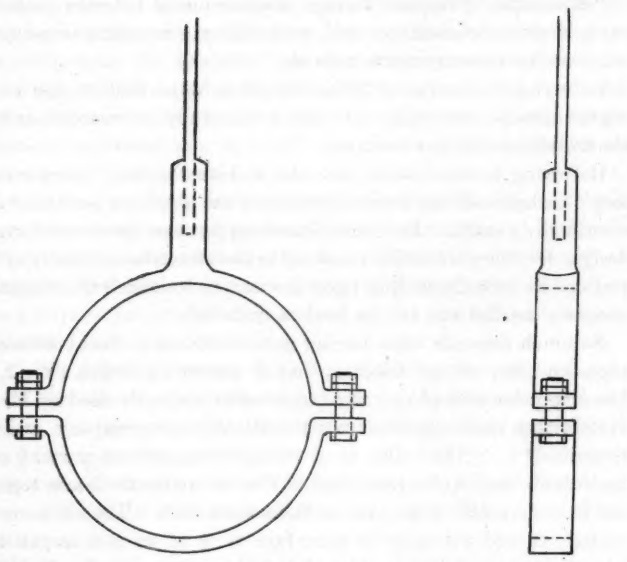


FIG. 1.

Under the second head, viz.: preventive measures in the case of cities where electric roads are yet to be installed, I wish to point out first, that the *kind* of electric railway system chosen will itself determine, to a large extent, the preventive measures required. If it is to be the single trolley system, such as we have been considering, then the track should be heavily bonded, or rails welded together, ample return feeders should be provided, and after the road is in operation, all underground pipes should be properly connected to return feeders at points located by careful tests as before described. The three-wire single trolley system is recommended by some as not being dangerous to underground pipes because the rails are "neutral," one portion of the trolley wire constituting the path for the outgoing current from the station and another portion constituting the return path. But the fact still remains that the current must pass through the rails for longer or shorter distances, depending upon the position and movement of the cars. Consequently leakage to and from the pipes is likely to

occur, but just where, or in how short a time destructive action on the pipes would result, it would be difficult to foresee. The danger territories would not be confined to the vicinity of the power stations as in the case of the single trolley system, but would be broken up into numerous indefinable and ever shifting districts, rendering it impracticable to apply the remedial measures hereinbefore described.

Briefly it may be stated that every direct current system that uses the earth or any conductor in contact therewith as part of its electrical circuit is dangerous to underground pipes. This covers all trolley systems except on elevated roads where the entire electrical system is insulated from the elevated structure or from the earth.

The "double trolley," the "conduit" and the "storage battery" systems, on the other hand, are not dangerous to underground pipes, because their electrical circuits are normally not in contact with the earth at any point. But questions of first cost, practicability, etc., present themselves very forcibly to railway companies when the adoption of any of these systems is recommended, and in a majority of cases the "single trolley ground-return system" will be chosen for some time to come unless state or municipal authority regulates the matter.

How soon such legislative action will be taken in this country it would be difficult to predict; but it may be of passing interest to note that recent news reports from Japan state that the municipal authorities of Tokio have decided to avoid the electrolytic corrosion of existing water pipes by compelling the use of the double trolley over the projected 85 miles of roads in that city. Double trolley roads have been in successful operation for years in several American cities, notably in Cincinnati.

As to the practicability of the conduit system, a recent number of the *Electrical World* states that as a result of the great satisfaction given by the Lenox Avenue Conduit Electrical Railway, during several months operation in New York City, it was announced last week by the officials of the Metropolitan Street Railway Company that horses and cables would be abandoned and all its lines of street railroad would be equipped for operation by electric power.

All the preceding systems use the direct current; that is the current flows steadily in one direction through the circuit. Now if it

were possible to reverse the direction with sufficient frequency injuries to pipes would be avoided. But a reversal every week, or every day, or every hour, would not be sufficient. Possibly a reversal every minute would answer, though one every second would be safer. But a current whose direction is reversed every second, or four or five times per second, is called an alternating current. This, then, is another means for preventing destruction of pipes, namely, to adopt the alternating current instead of the direct. Unfortunately it is not feasable to do this at present as no complete railway system using alternating currents has yet been placed on the market. There is good reason to hope, however, that this will not be the case a year hence, and then one more system will be added to the list of those which may be installed in a city without being a continual menace to the much-afflicted pipes.

There remains to be considered under the third head the question usually propounded by the water works man who has listened to a description of the way in which his pipes are being destroyed by railway currents and the means for locating and preventing the trouble, namely: "Who is to foot the bill?"

Now I shall not presume to offer any off-hand answer to this important question, the courts alone being authorized to render the final decision. But it may be interesting to refer to the case of a telephone company versus an electric railway company in the Superior Court of Cincinnati, January, 1891, in which the verdict was as follows:

"The order of the Court will therefore be that the defendant be enjoined perpetually from the use of the system of electric railway propulsion as now operated by them, or any other which will occasion similar disturbances to those now caused by the defendant's single trolley system."

In this case it was the chief contention of the defendant that "because it had full power to operate by electricity under the law, therefore it could not be held liable for damages resulting therefrom, such loss to plaintiff, being in legal parlance, *damnum absque injuria*, and if plaintiff wishes to avoid the loss, it must adopt safeguards in the shape of a metallic circuit to avoid the difficulty." Now this way out of the difficulty was open to the telephone companies, and has been generally adopted by them; chiefly, however, to protect themselves against inductive disturbances from electric

lighting as well as railway circuits. But no corresponding remedy applicable to pipes subjected to the action of railway return currents is presented to water and gas companies. On the other hand, it is perfectly practicable for the electric railway companies to adopt the metallic circuit, that is the double trolley system, whereby the electrolytic action complained of could be wholly prevented. Furthermore, the judge states in the case referred to, that where one corporation is granted a right by legislative enactment which may be so exercised as to injure or interfere with the right previously granted to another, the presumption of law is that the legislature intended only such uses as were consistent with the rights of the first corporation. A case is then cited in which "plaintiff was a gas company which had laid its gas pipes, by virtue of a public grant, under a street which the defendant, a public corporation, was charged with keeping in repair, and upon which it used such heavy rollers as to injure the pipes of the plaintiff. The rollers used were economical and well fitted for the purpose; but it was held that unless the defendants were expressly authorized by statute to use rollers of the size and weight of those which did the injury, defendant could not justify under the duty to keep in repair which might be discharged by rollers of less weight and without breaking the pipes." I have presented this case at some length because it seems peculiarly applicable to the case under consideration, for here was a case of "a public grant to a gas company enjoyed in a certain way, followed by a grant to the defendant to exercise another grant, which, if exercised in one way, would injure the plaintiff's enjoyment of its rights, and which, if exercised in another, would not." Similarly in the case of electric railways, the act upon which the legal injury is founded is not the operation of the road by electricity generally, but the employment of that specific kind of electrical system which by reason of the use of a "ground return," inflicts injury upon gas and water pipes. Again, since facility and speed of transportation are the primary purpose or benefit, in consideration of which railway companies enjoy their franchises to use the electric current, it would be pertinent to ask whether the single trolley is superior on this score to the double trolley system. It is generally conceded that there is no marked difference between them in this respect. The adoption of the double trolley or other system not employing the ground return is, however, not the only,

though, from the electricians' standpoint, it is the best remedy for damage from corrosion. My earlier remarks have indicated a method by which the ground return may be rendered comparatively harmless to underground pipes.

In conclusion, then, it is difficult to see how the railway companies can escape the charge of negligence and responsibility for resultant injuries if it can be proved that, after being notified that injury was being done to gas and water pipes by the electric railway currents, the railway companies failed to adopt proper remedial measures.

DISCUSSION.

MR. WINSLOW. In a single trolley system, as we well know, the return current goes through the rails, and the wire between the rails, and in so doing it has a chance to escape to the water pipes or other conductors which may be of considerably higher resistance, but still do take quite a quantity of the current. In the double trolley system there is supposed to be entire insulation from the ground, but I find that there are no insulators which are perfect, and some of the current is bound to escape; and, as Professor Storrs says, a very small current will do the damage; and there is more or less trouble even with the double trolley system; in some cases a good deal of trouble, on account of imperfect insulation. The damage that is done, being out of sight where it cannot be seen by the people generally, is not realized by them, and they really do not know how much it is costing them.

Now the only sure remedy that I can see consists not in improving the single trolley system or the double trolley system, but by the substitution of that which at the present time is not deemed practicable, namely, the storage battery system. In that the electricity is generated and used in the car, and there is no chance for it to travel through the pipes or any other conductor; and until this system is put into use in my opinion the public will have to stand the damage resulting from the use of existing arrangements. I think within ten years, possibly in less time, the wires which are now carrying the currents will be useless for that purpose, and our streets will be freed from them and the power to run each car will be carried on it.

MR. GILBERT. Mr. President, I would like to ask how long it is after an electric road is put in before this damage to the pipes

which is spoken of becomes noticeable? This is something which affects nearly all of our thrifty towns, for they are all being reached by electric roads.

PROF. STORRS. Well, there is a great deal of information on the subject; that is to say, we can give many instances in which pipes have been very rapidly corroded. If I remember rightly, Mr. Barrett, the chief electrician of the Brooklyn Subway Board, states that there is one particular place in Brooklyn where a 6-inch cast-iron main was destroyed, or at least rendered unfit for use, in a very few months, I will not attempt to say how many, although I think it was within four or five. Mr. George P. Low, of San Francisco, also states that a large main pipe, an 8-inch pipe, I think, in the street in front of the station was destroyed repeatedly in a very few months, I think even more rapidly than that in the case mentioned in Brooklyn, although I am confident that in this case it was not a cast-iron pipe, but wrought iron, which is used so much on the Pacific coast. This indicates something as to the rapidity with which the damage takes place; but, of course, it might be going on so slowly in other places that it would be difficult to say at the end of 10 or 20 years whether the pipes had rusted out or had been acted upon by something in the soil itself, or whether the electric current had had anything to do with it.

In regard to that matter, I might say, it is well known that if two dissimilar metals are put into the earth, which usually contains certain salts, an earth battery is formed, which produces a small difference of potential and the current is sufficient to cause the electrolytic action; so that even if there were no electric railroad this small electric current would be continually circulating and affecting the pipes. The idea of preventive measures is that they would probably prevent rapid destruction of the pipes, and in fact they would so much delay it, and protect the pipe to such an extent, that it would be difficult to say whether the pipes had really been injured by the electric road, or whether they had been destroyed, as they normally are, through the action of such materials as are in the soil. Pipes do not last forever under any circumstances.

MR. HAZEN. Is it possible that induced currents in the pipes should prove injurious, Prof. Storrs?

PROF. STORRS. I should think there was no possibility of a current of such size as to cause any damage being induced in the pipes.

The pipes which are most likely to be injured are those near the station, because the electricity enters them at remote points and will follow them to the neighborhood of the station and will there leave them and go into the earth on its way to the station. The end of a pipe in the vicinity of a power house is very likely to be the place where the greatest electrolytic action will take place.

MR. FISH. We have two miles of pipe with an electric railroad near it, over which cars run every seven minutes 18 hours out of the 24. I have not discovered any damage, although I have examined for it, and although the pipe line terminates within 200 feet of the power house. I thought that was what was helping it, but I may be wrong about it.

MR. CHASE. There is another question which I fancy may be of interest to water works men present, suggested by the last remarks, and that is how small a power plant would be likely to have a detrimental effect upon the water works system. For example, would the power plant in Burlington be likely to have a detrimental effect on the water works system you have here?

PROF. STORRS. The only way to know about that is to make the test and find it out. It would depend very much on the location of the pipes, and as to how well the rails were bonded. It would be entirely indeterminate on general principles. Supt. Crandall tells me that, here in Burlington, one service pipe has been destroyed by electrolysis where it crossed the street passing close to the rails; this was near the power house. Our electric road has been running two years.

MR. G. S. WILLIAMS. Mr. President, I am happy to say that in the city of Detroit we have not been able to determine that we have had any results from electrolysis, but on the other hand we are not able to see any reason why we should not have. As near as we can find out all the conditions required for producing these bad results are present with us. We have discovered that there is a decided difference of potential between our pipes and the rails at certain points which leads to a flow from the pipes to the rails, and at other points we have found where the current is going into the pipes. Portions of our electric railway system have been in operation for over five years, and the part which has been in operation longest has been depending for its bond simply upon the tie-plates of the rails, which are laid directly over a water main. And still as I say,

we have not determined that there is any electrolytic action going on. It may be, however, that the immense consumption of water in Detroit tends to obscure any additional loss that electrolysis might produce. (Laughter.)

There is one thing that has occurred to me as a possible remedy, which I would suggest. The principle upon which the electric current flows, is that it takes the easiest paths, or takes paths in inverse proportion to their resistance; that is the greater the resistance the less the flow of electricity. Now, if we can make our water mains of high resistance, there will be very little flow through them. While it is true that the damage occurs at the points where the electricity leaves the main, if the line is of high resistance very little electricity will go to it, and it has been suggested that if a joint were devised which would be virtually non-conducting or which would be a very poor conductor, it might work as a remedy against the effects of electrolysis. We know, of course, that the electricity will very readily flow through the lead in the joints, although it is not a good conductor. I do not mean that the insertion of an occasional non-conducting joint would be a remedy, but I am inclined to think if every joint in the pipe were made of a non-conducting material it would have quite a decided effect to prevent the flow of electricity through the pipes.

MR. WINSLOW. I don't know but the gentleman is right, Mr. President, but I was talking with the Superintendent of the Gas Works in Cambridge recently, a city adjoining mine, and he told me that their joints are all laid with cement, and that that is just where the trouble occurs. It is from the passing of the current from one pipe to the other. The cement between the pipes being of a higher resistance, the current passes from one pipe to the other through the earth, and the consequence is that the pipes are very badly eaten and a great deal of trouble is caused. And so with cement-lined pipe, which a great many of us know about, more especially the bell and spigot form, the style which was made several years ago. The spigot end of one pipe is put in the bell of the other, and that brings the iron against the cement lining, the space between is filled with cement and it is then covered with cement, so that there is practically a cement insulation. And I know that in case of lightning striking the pipe, the pipe almost invariably bursts at those points and not in any other place. So I would not favor

any attempt at insulating the joints to prevent the action of the electric current on the pipes.

MR. WILLIAMS. I would like to say, Mr. President, that this is just the kind of information I have been looking for.

MR. GILBERT. It seems to me, Mr. President, this subject is in rather a crude state as yet, but it looks very reasonable and very natural that electricity from the trolley wires should get at the pipes. Yet when we look around the country, wherever we find a smart town nowadays it has an electric railroad and it almost always has a system of water works, and in many cases the railroad tracks are laid directly over the water pipes. Most of us are familiar with towns that have had these electric roads for the last five years, and yet, in many of them, no damage to the pipes has yet been observed, although it does not follow that if the pipes were taken up it might not be found they had suffered from the action of the electric current We must have water pipes and we must have electric roads, and I suppose the time will come probably when we shall find out just how to manage it, but evidently there is something yet to be learned.

MR. MILNE. I was much pleased, Mr. President, with Professor Storr's paper, and I think it touches the root of the matter. I come from Trolleyville, called Brooklyn, and allusion has been made to some of the characteristics of electrolysis as we have experienced its action in that city. What the Professor remarks is true regarding a composite metal incorporated in a service pipe. Take, for instance, a galvanized iron pipe. There is naturally a galvanic action there, without any aid from trolley currents, to produce a rapid deterioration in the pipe. That is our experience in the city of Brooklyn. Perhaps the greatest potential of the entire electric railway system of Brooklyn is concentrated in Third avenue. On that line there are many galvanized iron service pipes, and their destruction after the introduction of the electric railway was very marked. Now the legal aspect of this matter is a very serious one, and it is just at this point that municipalities will have to deal with the electric railway companies in court; that is, to determine what amount of electrolysis pure and simple, caused by the electric current, takes place in these service pipes; and that is the study of the electric subway commission today in the city of Brooklyn. Now, regarding our large mains, one incidental case has been men-

tioned here, but I am not altogether satisfied that it was due entirely to the action of electrolysis. It may have been in some respects, and not in others. But at all events we have had sufficient experience to protest against Superintendent Starrett's joints being placed upon our main pipes for the purpose of removing the negative current. We have steadily adhered to the principle of keeping our mains intact from the trolley wire connections. City Engineer George H. Benzenberg, a man well known to many people here, had a very sad experience in Milwaukee when it permitted the negative wires to be attached to the water mains. It resulted in considerable trouble, and the connections were abolished. The consensus of opinion of all water works men through the country, who have studied the subject carefully, is that it is unwise to allow any electric negative connection to be made with our water mains.

PROF. STORRS. I only want to say that this method which I presented seems to have met with a good deal of favor, and if certain elements in the method may have been applied to a certain extent in some cities without producing good results, I do not think that should be taken as conclusive evidence as to the inefficacy of the method, as a whole, when it is properly applied; which involves proper bonding of the rails and the provision of ample return wires, so as to reduce the danger territory to the smallest area possible, bringing it down very close to the vicinity of the power-house; and then running the return feeders from the pipes in that danger territory into the power station.

MR. CRANDALL. Do I understand you, that in your opinion in some of these instances, where wires have been attached to the pipes for the purpose of lessening the danger to the pipe, that they have been so placed as to have increased rather than diminished the damage?

PROF. STORRS. Oh, yes. It is an essential of the method that no wire should be placed between the rails and pipes where the current tends to flow from the rails to the pipes. It is very easy to cause more trouble than is prevented if the remedy is not properly applied.

CALORIFIC DETERMINATION OF THE VALUE OF FUEL.

BY

GEO. H. BARRUS, C. E., BOSTON, MASS.

[Read Sept. 13th, 1895.]

There are two systems of measurement employed in the determination of the calorific value of coal, which are in more or less common use. The first, and most widely known, is that which is based on a chemical analysis of the fuel, and the second is that obtained by calorimeter test.

Chemical analysis furnishes an indirect method of accomplishing the object, inasmuch as it first involves a determination of the component elements in the coal, and afterwards a computation of the heat of combustion of the complex body by adding together that of the various constituents. The calorific value of the elements of which coal is composed, such as carbon, hydrogen and sulphur, was originally determined by the use of a calorimeter, so that in reality the employment of chemical analysis is but another method of calorimeter measurement, although it obtains the result in a roundabout way.

The calorimeter test determines the calorific value of the coal by actually burning it, and measuring the quantity of heat which is generated in the combustion. It furnishes a direct method of accomplishing the desired object.

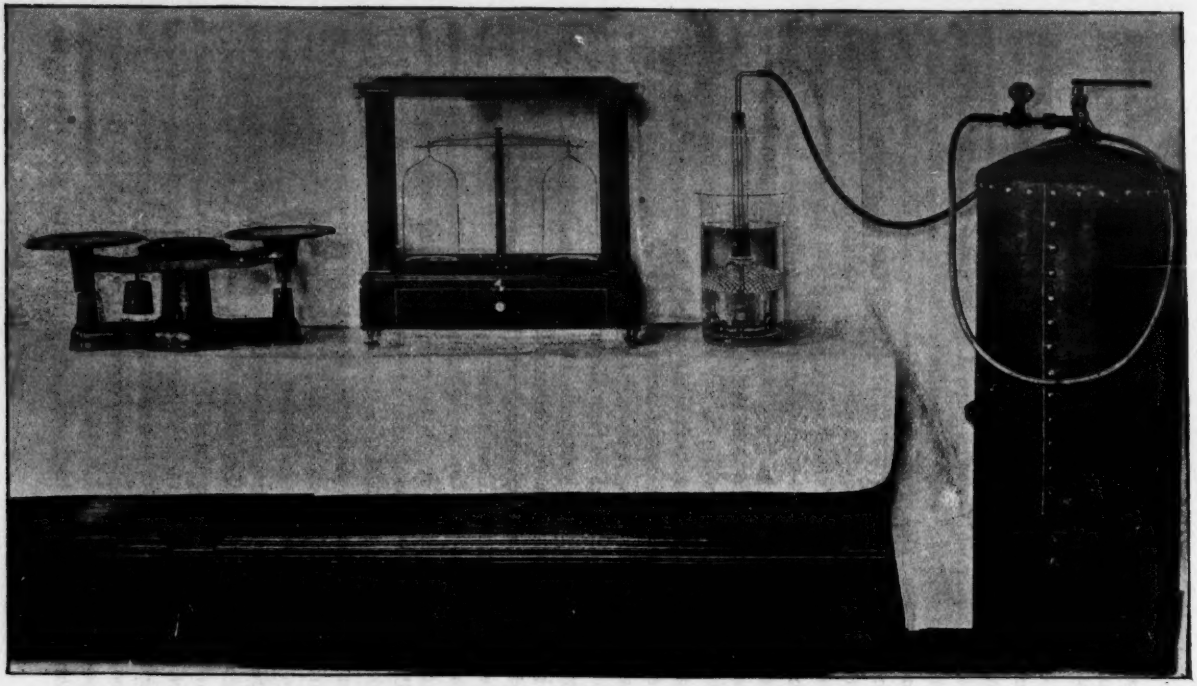
This subject is not a new one, but it does not seem to have awakened much interest amongst engineers until a comparatively recent date. It is now coming to be regarded as of considerable importance, and this is a reason for bringing the matter to the notice of the association. In doing this it is not my purpose to enter upon an extended discussion of the general subject of calorific determinations of coal. My object is rather to show the actual process of making these determinations, and exhibit the apparatus at work. It is to be hoped that the exhibition will be of some interest

as a novelty, if nothing more; but apart from this it may serve in some measure to popularize the calorimeter method of testing coal, which at the present time seems to be of growing importance.

I think everyone will agree with me, whether familiar with the subject or not, that it is desirable to have a standard of comparison by which to judge of the real value of fuel. Differences in the conditions under which coal is burned in the boiler furnace, and differences in the efficiency of the boiler itself, make it impossible to judge of the value of the fuel, if dependence is placed simply upon the results obtained with it in practice. The calorimeter test furnishes a standard which is unaffected by variations in the conditions noted. It does not furnish all the information needed to judge of the value of the fuel in practical work, but it eliminates the conditions subject to variation, and at least brings the indications as to the value of the fuel down to a uniform basis. This is a result which it is certainly worth while to achieve, and although this work may seem to those who are unfamiliar with it as belonging to the theoretical department of steam engineering, it has, in reality, a wide practical application.

The form of apparatus here shown is one which I have employed during the past five years. It has been used in testing nearly all the principal varieties of coal mined in this country. The results obtained from the various coals which have been tried with it range, from 8,500 B. T. U. per pound of coal, to 15,221 B. T. U. per pound of coal, the former being a sample of Illinois bituminous coal, and the latter, New River semi-bituminous coal from Virginia. The figures for the same coal based on combustible were 12,839 for the former, and 15,334 for the latter. The former had 33.8 per cent. ash, and the latter a trifle less than one per cent. The results obtained from other coals lie between these extremes.

As will be seen by inspection, the instrument is of rather simple construction, consisting in the main of a glass beaker and another glass vessel bell shaped, which forms the combustion chamber in which the fuel is burned. The base of the combustion chamber is of metal, and is held to the upper part of the chamber by means of spring clips, so that the two parts can be readily disconnected. The coal is burned in a platinum crucible which rests in an elevated position at the top of the base, and dependence is placed upon a current of oxygen which enters through the small glass tube inside,



APPARATUS FOR TESTING THE CALORIFIC VALUE OF COAL.

for supporting the combustion. When the instrument is working, the combustion chamber is submerged in water in the glass beaker. The pressure of the current of oxygen passing into the chamber serves to keep the water out of the interior. The gas which is formed during the process of combustion passes downward through the perforations in the base, and escapes to the surface of the water, bubbling up through the intermediate space. A wire screen surrounding the combustion chamber intercepts the bubbles of gas, and thus aids in the transfer of heat to the water. In making the test the essential data which is sought is the number of degrees of temperature which a certain weighed quantity of water is raised by the combustion of a certain weighed quantity of coal. The quantity of water generally used is one kilogram, that is 2000 grams. The quantity of coal, a single gram. With this relation of weights, and the proper allowance for the calorific equivalent of the material of the calorimeter the heating of the water one degree Fahrenheit represents in this instrument about 2150 heat units. The rise of temperature for a good quality of coal would thus lie between 6 and 7 degrees Fahrenheit. The thermometer used in determining the temperatures is graduated to fiftieths of a degree, and it can be read to hundredths. To eliminate the effect of radiation either inward or outward, the temperature of the water is so adjusted at the beginning that the temperature of the atmosphere lies midway between the initial and final readings.

Mr. Barrus then proceeded to illustrate the working of the apparatus using a sample of Pocahontas coal.

DISCUSSION.

MR. WILLIAMS. Have you ever experimented with oil, Mr. Barrus?

MR. BARRUS. I have never used this apparatus with oil. Oil is so inflammable it is difficult to burn it satisfactorily. I have tried to mix it with coal and get a test that way, but I have never had occasion to experiment to any great extent in that direction.

MR. COGGESHALL. Would that be a practical apparatus to introduce in the daily work of a department at the pumping station? In other words, would an ordinary person find it very difficult to to use the apparatus so as to get accurate results?

MR. BARRUS. I will leave it to you to judge for yourself. I

think it would take a pretty careful man to make a test that could be relied upon.

MR. NOYES. I would ask Mr. Barrus if we can assume that the value of the coal for producing heat is in a direct ratio to the results shown in this test, or whether there are not other conditions in actual work so that the relative results vary from those indicated by the test.

MR. BARRUS. I suppose you all know that by firing under different conditions the efficiency of a boiler can be varied by as much as 10 per cent., there would be even more than that, with very bad as compared with very good firing, but with different conditions of good firing there may be as much as 10 per cent. variation. For instance, you could carry heavy fires, and then again light fires and make that difference. But taking the same boiler, operated with the same capacity and employing the same system of firing, different varieties of eastern coals ought to show about the same relatively in the boiler in actual work as they do in the calorimeter. With western coals, which are very volatile, that statement does not hold good, because there is a very large amount of loss from incomplete combustion.

I was led into this line of investigation in the first place by some tests that I was making with two different kinds of boilers in different places, and with different kinds of coal, and I wished to determine the relative efficiency of the two boilers; that is, their relative economy for practical work. Without knowing the absolute calorific value of the two coals, I had no basis to start from. I made the test on one boiler, and I got different results from what I expected, and so I changed the fuel and made one test with Pocahontas coal and got inferior results. Then I used Cumberland, and the result was about seven or eight per cent. less, not even as good as I had obtained with the Pocahontas. I was dissatisfied, and this induced me to commence work in this line, and I found that by testing the two coals the difference in the calorimeter results just corroborated the difference in the result of the work of the boilers. Pocahontas on that test showed high, and the Cumberland was poor. I should not want to say from that that the Pocahontas is the best coal, although a great many of these figures do show the highest results from Pocahontas coal.

THE SECRETARY. I would like to ask Mr. Barrus about a sample

of coal he has used, Clearfield coal, which seems to be quite high in heat units, while the coal is rated rather low among users of coals, and sells at a correspondingly low price. The record of the test would seem to indicate that the coal requires some peculiar firing; that is, that firemen generally do not get the full value of the coal.

MR. BARRUS. As I recall that particular sample, it was one sent me by some party who dealt in Clearfield coal, and I think it was selected as a particularly good sample, because I have tried Clearfield in other cases, where I took the sample myself, with not as good results. Here is one that gave 13,640 against 14,580 for the one referred to, and another one is only 12,500. I never tested a great many samples of Clearfield coal, and I do not know how they usually run, but there is a wide variation between 12,500 and 14,580.

MR. SMITH. Do you find that the tests vary considerably on different lots of coal from the same mine?

MR. BARRUS. Yes, they do. Take the Cumberland's, for example. I have a dozen varieties of Cumberland, and they run from 14,200 down to 12,900. They are not all from the same mine, but they came from the same region.

MR. HOLDEN. Would there be much variation in several small samples taken from the same carload of coal?

MR. BARRUS. I wouldn't trust one sample. I had one brought to me the other day that had only three-quarters of one per cent. of ash in it, and I have recently had a sample of the same kind of coal which left only half of one per cent., an amount so small I could hardly measure it. When I went to the coal pile, and obtained a sample myself, there was three or four per cent. of ash. For this work there ought to be two or three hundred pounds, from different parts of the pile, broken up and reduced, and a sample of that taken, and re-sampled and re-sampled until a small average sample is obtained.

MR. SMITH. Do your tests point in the direction that the smaller the amount of ash the better the coal is?

MR. BARRUS. Yes, generally that is true.

MR. SMITH. It seems to be that a practical test can be made by almost anyone weighing the coal on its way to the boiler, and then afterwards weighing the ash.

MR. BARRUS. That is a good practical test, but it is not abso-

lute. Now, take these same figures and reduce them to combustible. The figures on combustible with seventeen different samples of Cumberland coals, run from 15,300 down to 13,800. Hydrogen produces more heat in burning than carbon does, and as the proportion of hydrogen in the coal varies, that throws it all out. If it was all carbon and ash, then the heating value would vary with the percentage of ash. But with soft coals, the hydrogen varies, and that has a powerful influence on the calorific value. Anthracite coals, on the basis of combustible, vary, as I have the records here, from 14,500 down to 12,800. Here are four samples, from different parts of Illinois which, on the basis of combustible, run from 12,800 to 13,600, only five or six per cent. of difference, and yet on the basis of value, they run from 8,500 up to 12,700, about a third more; so that in that case the variation in ash would follow very closely the variation in the real value.

MR. NOYES. I trust that this line of investigation that Mr. Barrus has advanced, will be carried forward by our members, and I think practical results will be brought out which will be of great benefit to most, if not all, of our water works systems.

WATER SUPPLY OF LYNN.

BY

JOHN C. HASKELL, SUPT., LYNN, MASS.

[Read Sept. 11th, 1895.]

The water supply of the City of Lynn is furnished from the Saugus River and its tributaries. This river flows from Lake Quannapowitt, in Wakefield, through Lynnfield and Saugus, and forms a portion of the boundary line between Lynn and Saugus. The water from 22.91 square miles of its water-shed, flows by gravity to the pumping station.

The construction of our system of water supply was commenced in 1870. The first source of supply was from Breeds Pond, an artifical pond formed by a dam across the valley of Moore's brook, the nearest tributary of Saugus River to the city.

Breeds Pond when full has 22 feet of water at dam; contains 58.45 acres of water surface; a storage capacity of 262,563,000 gallons; a water shed including pond surface of 0.93 square miles. The dam was constructed upon an old dam. The original dam consisted of two nearly vertical walls of stone, the intervening space being filled with gravel. A portion of the front wall was taken down; the earth in front excavated to compact gravel. This excavation was filled with puddled earth forming a slope of 2 horizontal to 1 vertical and covered with riprap.

In 1878 the dam was raised and a stone coping put around the inside 2 feet high, set upon a solid foundation of masonry resting upon the original puddle wall. The main dam is 170 feet in length at crest; width of crest is 16 feet; wet face with slope of 2 feet horizontal to 1 vertical, paved; dry face solid masonry wall. There is a wing dam 100 feet in length at crest, 16 feet in width at crest, slope wet face 2 horizontal to 1 vertical, paved; dry face 1½ to 1. The spillway is situated at end of wing dam, is 25 feet in width, bottom and sides of heavy masonry. The waste water is allowed to

escape over paved steps and between masonry walls to the original brook below. When the pond was first taken the trees and bushes were cut off slightly above the flow line and all debris was burned; no effort has been made to remove the soil. We can add to its storage capacity by constructing a new dam immediately above the site of the present dam with 55 feet of water at dam; a pond surface of 175 acres and storage capacity of 1,628,000,000 gallons. It will also be necessary to construct a dam across a narrow valley on the west side of the pond; depth of water at dam 24 feet. This reservoir can be fully developed without encroaching upon land not owned by the city. In 1873 Birch Pond was added by constructing a dam across the valley of Beaver Brook, the second nearest tributary of Saugus River. Birch Pond when full has 21.50 feet of water at dam, a pond surface of 82 acres, a storage capacity of 381,062,000 gallons with a water shed including pond surface .66 square miles. The dam is founded on loose gravel; the centre is formed of clay puddle 5 feet in thickness; the earth embankment is formed of gravel. The main dam is 270 feet in length 20 feet in width on crest, wet slope 2 feet horizontal to 1 vertical, paved; dry slope 1½ feet horizontal to 1 vertical. The wing dam is 600 feet in length and constructed similar to the main dam. A granite coping 2 feet in height extends the entire length of the main slope. The overflow is at the end of the main dam 12 feet in width, excavated through ledge and lined with heavy masonry walls. The waste water escapes between masonry walls laid on a solid rock foundation to the valley below. No greater expense was incurred in preparing the bed of this pond than in Breeds Pond.

In 1883 Saugus River at Howletts mill was connected by a canal and tunnel with Birch Pond, Hawkes and Penny Brook. Tributaries of Saugus River were connected separately by canals with the main canal. A 30-inch pipe was laid under Birch Pond from the lower end of the canal to the gate-house permitting water to be used from the canal without connection with Birch Pond. In 1886 a pumping station was erected at the upper end of Birch Pond over the tunnel, equipped with a steam engine and boiler of 60-horse power; a Webber centrifugal pump capable of pumping 12,000,000 gallons of water daily from the canal into the pond. This became necessary in order to fill Breeds and Birch Ponds when they were unable to fill from their own water sheds. A connection be-

tween the pipe lines leading from Birch and Breeds Ponds to the pumping station was made.

In 1889 Walden Pond was formed by constructing a dam across the valley of Penny Brook, the third nearest tributary of Saugus River, and it was thought advisable to construct a second dam across an arm of Walden Pond to give increased depth to the upper end. This upper pond was named Glen Lewis. The two ponds, however, should be considered as one, no means having been provided to take the water of the upper pond without intermixture with the water of the lower pond. Walden Pond, when full, has 17 feet of water at dam; a pond surface of 128 acres, and a watershed, including pond surface, of 1.31 square miles; a storage capacity of 403,163,000 gallons.

In constructing Walden Pond dam, the soil, stumps and mud were removed from the entire foundation, requiring for several hundred feet a depth of from 14 to 18 feet. A trench four feet in width was dug through the centre until compact gravel was reached. This trench was filled with puddled clay which was carried up within two feet of the top. The earth embankment is formed of gravel. The length of the dam on crest is 1,275 feet; width of crest 16 feet; slope of wet face 2½ feet horizontal to 1 foot vertical, and paved 15 inches in thickness. Slope of dry face 2 feet to 1, of earth embankment, with 2 feet of soil on top. A spillway situated near the end of the dam, 80 feet in length, has a solid masonry wall in the centre and wing walls at the ends with heavy paving in its bed, to the valley below. We can also add to the storage capacity by constructing a new dam immediately below the site of the present one with 45 feet depth of water at the dam, a pond surface of 333 acres and storage capacity of 2,800,000,000 gallons. To utilize this reservoir it will be necessary to pump the water from Hawkes' Pond into the upper 27 feet. Water from this reservoir can be delivered into Breeds Pond by constructing a conduit of 1,300 feet in length and through a tunnel 2,700 feet in length.

Glen Lewis dam is 330 feet in length at crest and 40 feet in width, with a spillway situated at the end, 25 feet in width excavated through ledge and lined with masonry; the inside slope of earth three and one-half to one and covered with riprap. Outside slope masonry wall with batter 1 inch to 5 feet. Glen Lewis Pond when full has a depth of 17 feet, a pond surface of 36 acres, a water-

shed, including pond surface of 0.36 square miles, and a storage capacity of 120,475,000 gallons. No greater expense was incurred in preparing the bed of Walden and Glen Lewis ponds than in Breeds Pond.

In 1894 an area of 11.50 acres of the bed of Walden Pond was cleaned of all soil and organic matter. An arm of the pond containing 12.80 acres, where the water was shallow, was separated from the lower pond by a dam constructed with soil removed from the bed of the pond immediately below. A pipe provided with a gate was laid under the dam. This work was commenced with the intention of thoroughly cleaning out the entire bed of the pond, expending in this direction the surplus revenue each year that would otherwise revert into the sinking fund. An additional area will be cleaned this year.

Hawkes Brook Pond is now being added to the supply by constructing a dam across the valley of Hawkes Brook to the fourth tributary of the Saugus River. The pond, when full, will have a depth of 25 feet of water at dam; a pond surface of 75 acres; a watershed, including pond surface, of 1.92 square miles; storage capacity, 300,000,000 gallons; main dam at crest, 1,350 feet, width 20 feet, both slopes 2 feet horizontal to 1 foot vertical; inner slope a loose riprap of about 2 feet in thickness; outer slope and top of dam to be covered with loam. A core wall will extend from bottom to within 3 feet of top of embankment; from bottom of core wall to top of dam will be 55 feet; core wall is founded in solid ledge. There will be a wing dam 210 feet long at crest core wall and side slope same as main wall; water at dam 18 feet. Waste way will be at east end of dam 5 feet below crest and will be excavated through ledge to the valley below. All soil above the level at which water can waste from the pond is being removed. The gate-house will be so arranged that water can be drawn from any desired elevation. Through the main dam there will be one 36″ and one 30″ pipe.

The reservoir is partly on embankment and partly in excavation; the lines were regulated by the most favorable contours. The area, including embankment, is about nine acres. Its water surface is a little less than five acres and its depth is 18 feet. The capacity of the reservoir at 16 feet is 21,000,000 gallons. The bottom of the reservoir is covered with clay puddle 2 feet in depth.

The embankment is 16 feet on top; outside slope 1½ feet hori-

zontal to 1 vertical; inside slope 2 feet horizontal to 1 vertical. The inside slope is paved with heavy granite paving laid on riprap. One force main 30″ inches in diameter, one of 20″ and a distribution main of 16″ extend from the reservoir to the pumping station. A 12″ distribution main for the high service enters the reservoir at the northern side. The pumping station is divided into an engine room 50 by 56 feet, boiler room 40 by 46 feet, and coal room 41 by 46 feet. The well room is 50 feet in length, 10 feet 4 inches in width and 13 feet in depth. The walls of the well room are of granite lined with brick and covered with cement. The chimney is 120 feet high, octagonal in form and rests upon solid masonry 16 feet in depth. The site for the engine house contains about 70,000 square feet of land and has a frontage of 200 feet on Walnut street

The pumping plant consists of an engine designed by E. D. Leavitt of 5,000,000 gallons daily capacity and built by J. P. Morris of Philadelphia, and an engine which is known as a Loretz high-duty duplex compound beam and flywheel, consisting of two engines each of 5,000,000 capacity in 24 hours. This type has been adopted in preference to any single engine, for should any portion of the duplex gets out of order, the other remaining half can be disconnected and operated separately. The motive parts consist of four vertical cylinders arranged in tandem pairs of 18″ and 36″ in diameter and 5½ feet stroke. The two engines are connected together by large and heavy disc cranks set at right angles to each other on a massive shaft, having a 20-foot flywheel, the whole weighing about 20 tons. The entire weight of engine is about 250 tons, is nearly 50 feet in height from base of central columns to top of beams, and occupies a floor space about 24 by 36 feet. There are two galleries, the first being the operating gallery, where engine is started. There are four patent Loretz lift pumps operated from two beams, each being 22″ in diameter by 33″ stroke, and connected so as to force a continuous current through a 30″ diameter force tube without noise or jar. This engine was designed by Arthur J. Loretz of Brooklyn, N. Y. Both engines are doing very satisfactory work. The yearly duty for 1894 being: Leavitt, 106,996,048; Loretz, 103,176,674.

The boiler plant consists of two plain horizontal tubular boilers, each 5 feet diameter of shell, and containing 77 tubes of three

inches outside diameter, and 16 feet long, with a steam drum three feet in diameter, and 6 feet high. Also a Moore Water Tube, and Moore's boiler of 200 horse power capacity, containing 96 tubes, 4 inch outside diameter, 17.5 feet long, 2 steam drums, 3 feet diameter, 19 feet long, Grater 5′ by 7′, Economizer in flue, with 250 square feet heating surface; furnishing a duplicate set of boilers, either of which is equal to run our engines.

HIGH SERVICE.

Up to the present time our high service supply has been drawn from the same Reservoir as the low service, the additional pressure being gained by a separate pipe running direct from the Reservoir to the Highlands.

To secure better service on the Highlands, a stand pipe 50 feet in diameter and 35 feet in height, with a capacity of 500,000 gallons is being constructed on the summit of a hill near by the present Reservoir The additional pressure given will be 33 pounds. The foundation is based on solid ledge, and consists of a brick wall laid in Portland cement around the entire area; the inside area between the walls is filled with concrete composed of one part Portland cement, two parts sand, and five parts broken stone, varying in thickness from 2½ feet at the greatest depth to 8 inches at the least.

The pumping plant is located in the low service Pumping Station, and consists of two pumps attached to the Loretz engine, so arranged and constructed as to draw their supply, either from the pump well direct or force main, to a capacity of 1,500,000 gallons per day. Also to be connected on their delivery, so that they can deliver either to the high or low service reservoir, or both, at the same time. In this manner the capacity of the pumpage will be increased in the low service system as well, to the extent of three million, and the entire pumping system arranged to reduce the extra fuel consumption and maintenance to a minimum. There is also included an auxiliary pumping engine for a duplicate plant, so arranged as to either pump direct from the pump well, at the rate of one million gallons per day, into the high service or one and a half million into the low service.

FIRE PURPOSES.

The City of Lynn is exceptionally provided with a water supply for fire purposes. In the business portion of the city 1,000,000 gal-

lons per hour can be delivered if necessary, and not reduce the pressure below 45 pounds.

To show the purity of the water in our supply we present the following table, taken from the Report of the State Board of Health for 1890, page 532, which gives the number of deaths from Typhoid Fever per 10,000 of the living population from the same cause for the four years 1886–1889.

Lawrence 10.30, Lowell 9.55, Fall River 6.40, Holyoke 6.13, Chicopee 6.06, Haverhill 4.98, Boston 4.05, Cambridge 3.80, Worcester 3.11, Lynn 2.24, an average ratio of 5.43. The death rate in Lynn is the least of any and less than one-half of the average. From 1889 to 1893 the death rate of the City of Lynn from Typhoid Fever per 10,000 has been 1.73. In 1894 during which time we have been using the waters of Saugus River, the new supply, the death rate has been 1.38 per 10,000.

We also find from a table compiled from the census of 1890 showing the death rate from Typhoid Fever in cities in the United States with over 50,000 inhabitants that Lynn has the least death rate of any but one of the 54 cities, and equally as good as that, and but one-fourth of the general average. These figures show that we have nothing to fear from the quality of our water in this direction.

While it is not assumed that the periodical vegetable growths occurring in all surface water reservoirs are dangerous to health, the presence of large numbers of these organisms render the water disagreeable both in taste and odor.

To avoid as far as possible using water containing disagreeable organisms, samples are taken weekly from the surface and bottom of the different reservoirs and biological examinations are made and recorded. By watching the weekly growth of the different organisms, much valuable information in relation to our water supply is gained.

The time of the greatest growth of the organisms in each pond varies to such an extent that we have not been obliged to use the water of any source when the quality was the poorest. The growth to maturity and subsequent decay of some of these organisms is very rapid.

No organism liable to come from sewerage, or any injurious to health have been discovered. The value of these examinations is to

give a full knowledge of the condition of each specie of organism in each source of supply; the probable growth to be anticipated; the nature of each, whether injurious or harmless, and to gather all information possible as to the quality of the water before it is taken for use.

From our supply, as at present constructed, water can be drawn from five sources separately, or by twelve different combinations, from two or more sources.

It has been observed that the water containing some species of organisms improves in quality in its passage from the ponds to the city, while water containing other kinds deteriorates, it having been our experience that water with but slight taste, or odor perceptible in the ponds, became disagreeable when delivered for consumption. From this brief explanation the advantage of acquiring full information about the water in each source of supply can be seen.

DURATION OF SUPPLY.

Until 1894 a water-shed of 5.18 square miles has supplied all water needed. In 1894 water was first taken from Saugus River; this watershed comprises an addition of 17.73 square miles, making a total of 22.91 square miles, or more than four times our former area. Above Pranker's Mills, the point at which the canal connects with the river, 8.50 square miles has less than 50 population to a square mile, and will not be contaminated with sewage from any city or town. It can be provided with storage reservoirs sufficient to utilize the entire rainfall, as it becomes necessary to meet the increased comsumption, by raising the dams of our present reservoirs. No reason exists why this supply should not increase in purity as the reservoirs attain greater age, and properly developed, should furnish a pure supply for twenty years in the future.

FUTURE SUPPLY.

When the limit of supply from Saugus River is reached, our natural source of supply is the Ipswich River, which contains a water-shed of 34 square miles, situated at a sufficient elevation to flow directly into the pump well at our Pumping Station by gravity.

This water-shed is adjacent to the Saugus River water-shed. The water from an additional area situated below this point of 17 square

miles can be delivered into the Hawkes Brook valley at a comparatively slight expense and it is practicable to include a total of 96.70 square miles of the Ipswich River in our supply.

To still further enable you to judge of the quantity of water that can be provided for Lynn in the future, we will draw your attention to the total water-shed of the Ipswich River available, considered together with that of our present supply, as amounting to 119.60 square miles.

No charge is made for water used at fires, watering streets, drinking fountains, flushing sewers, public buildings, or for any city purposes. The works are self-sustaining, the yearly receipts being more than sufficient to meet the interest and maintenance.

DISCUSSION.

MR. NOYES. As I understand, Mr. Haskell, you have had systematic and careful examinations of the water made from time to time by your special biologist, and you have also treated some portions of your reservoirs by covering them with gravel or sand. Have you from those examinations reached any conclusion with regard to the benefit derived from covering?

MR. HASKELL. In answer to Mr. Noyes, Mr. President, I will say that, as I briefly stated in the paper, we have commenced to clear out the bed of Walden Pond, and while I did not enter into it at all in detail in this paper I will, if circumstances permit, present another paper at a not distant date on what we have done in Walden Pond and what we have found out. I have made a very careful examination of the bed of the pond both before and after the work was done. We have recently run the water out of the pond, in connection with continuing our work in improving it, and I have had photographs taken which show very plainly the character of the work that we have done, and the dividing line between the work and the original soil. I have also had examinations made of the soil from the natural bed of the pond, and then from the gravelled portion, perhaps only three or four feet away; and the differences observed are very interesting.

MR. NOYES. I think such information as that would be of great value to many of the water works officials who are making studies in that line. I have known of the work Mr. Haskell has undertaken, and hope we shall receive a paper from him. But I might

ask you to state briefly whether there is an appreciable improvement in the quality of water resulting from that work?

MR. HASKELL. We have had a very favorable year this year. In addition to cleaning out a portion of the bed of the pond, as late in the fall last year as we could, we burned the whole bottom of the pond over. We took kerosene oil and sprinkled it over the bottom, and we got a very hot fire. The small area that we separated from the pond, the 12.81 acres and the 11.50 acres that we cleaned, ought not to have made any very appreciable improvement, but the actual facts of the case this year are that while previous to this year we were not able to use the water of Walden Pond after the 23rd of May in any year, owing to the growth of algæ in it, this year we had absolutely no algæ in it whatever, while in our other ponds we had nearly the same amount of growth of algæ as formerly.

PUMPING STATION MANCHESTER MAIN SERVICE.

PROPOSED SEACOAST MANOEUVRES HIGH SCHOOL CADETS.

A SHORT HISTORY OF THE MANCHESTER HIGH SERVICE

BY

CHARLES K. WALKER, SUPT., MANCHESTER, N. H.

[Read Sept. 13th, 1895.]

In his report of 1874, Mr. Fanning suggested that when a high service should be required, that an additional main, 24 inches in diameter, should be laid from the pumping station to the city. At that time there were but 9 or 10 houses too high to be supplied from the low service pipes, and they were supplied by water from good wells or springs in their neighborhood. The water for the low service is pumped by water power, and this plan contemplated pumping the high service supply in the same manner.

In 1880 the water in the lake, from which the supply is derived, became so low that it was necessary to deepen the channel, in order to get water enough to supply the city, and to furnish water power for pumping it. It was at this time that there was first serious talk in regard to the necessity of using steam at some future time to supplement the water power. After having deepened the channel at this time, the lake gave us water enough for 13 years, during which time the consumption increased from 1,200,000 to over 2,000,000 gallons per day, and as it requires seven gallons of water to pump one gallon furnished to the city, towards the end of that time it was not always possible to maintain sufficient pressure in the higher portions of the city, and the residents of those localities began to complain of the service.

The Commissioners had been considering the subject, and were of the opinion that it was best to have a high service, operated by steam, and so connected that it could also be used for pumping into the low service pipes, in case the water power became inadequate. The project, however, was opposed by a large part of the people,

and the daily press was unfavorable to it, You know very well that in order to get money for any improvement the public must be in favor of it.

A site for a high service reservoir was easily found in a range of hills on the east side of the city, but the route for the force main leading to it was not so easily selected, and the Commissioners concluded to employ a first-class engineer to look over the country and to make estimates, so that when the time came they would be prepared to recommend a suitable scheme. They secured the services of the late Marshall M. Tidd in 1890, to examine the different projects which had been suggested, and to make estimates for them. I will say that his estimates, so far as we have carried out his plans, have proved to be correct.

Mr. Tidd made estimates for three different pipe routes from the lake to the reservoir, and he also made estimates for taking the water from the low service and pumping it to the high service, but as this involved a double pumping, and would not in any way benefit the low service, it was abandoned.

It was suggested, as one of the schemes, to take water from Stephens' pond. This is a small pond entirely separate from Lake Massabesic, from which the main supply is obtained, and the water was said to be good by the chemist. My first doubt in regard to this source, was when a gentleman from Lynn, at one of our meetings some years ago said, "Never take a water from but one source of supply at once, for if you do there will be trouble, as each taker will wish he could have water from the other source." The question, however, was settled at once by Mr. Tidd, who said that he would not recommend water from that source.

A line was finally selected from Lake Massabesic, which we have every reason to believe was the best one. Both the pipe line and reservoir were constructed under the supervision of Mr. George E. Evans of Boston. The reservoir caused us a little anxiety, as it was built on a ledge full of seams, but it has never shown any signs of leaking; it will hold 4,000,000 gallons, and a full description of it is given in the report of Messrs. Rice and Evans, engineers. The water is pumped by two 3,000,000 gallon high duty engines, built by Henry R. Worthington. They were tested by Mr. Dean, who reported that they filled the contract. Pumping together they will supply 6,000,000 gallons into the low service, but will not do it into

the high service pipes. If the contract had read "both," instead of "each" where it says that "each pump should pump 3,000,000 gallons," perhaps it might have been different. The force main is 20 inches in diameter, and it is a little over 3½ miles long. The pumps work against 120 pounds pressure, or about 250 feet head. We have tried to operate both pumps at once, but this increases the pressure to 128 pounds, and we have not found it advantageous.

In conclusion I will say that we have got one of the best high service systems in the country, and the best part of it is, we got it in just in season to prevent a water famine.

The following description of the High Service is taken from the report of George S. Rice and George E. Evans, engineers above referred to.

SOURCE OF SUPPLY.

The pumping station is located on the west shore of the westerly part of Lake Massabesic and near the northerly end of the lake, and is a little less than two miles north of the outlet which supplies water to the low service pumping station. The intake pipe is cast-iron, twenty-four inches in diameter, and extends into the lake 255 feet from the shore wall. The end is covered with a heavy brass screen of three-quarter inch mesh, and is eight feet below the top of the dam. The elevation of top of dam is 147 feet.

PUMPING STATION.

The building consists of engine, boiler, and coal houses, all connected, and the walls are built of common bricks laid in red lime mortar, having granite underpinning, window and door sills.

The underpinning is laid in horizontal courses and the height varies from four to five and one-half feet. The roofs over the engine and coal houses are supported by wooden trusses and covered with slate. The roof over the boiler house is flat and constructed of large southern pine beams and two-inch spruce plank covered with tarred paper and gravel. The flat portion of the engine house also has a graveled roof. The cornices are made of galvanized iron,

and the finials, hip and ridge rolls are copper. The engine room floor is made of two-inch spruce plank covered with southern pine one and one-fourth inches thick.

The floor in the boiler room is tar concrete and brick, and in the coal room is tar concrete. The elevation of the engine house floor is 158.5 feet and the boiler room floor is two feet and eight inches lower. The chimney is circular in plan and 100 feet and 9 inches in height above the foundation, and built of common bricks laid in red lime mortar, with an addition of about one-third cement. The first seven feet were laid in cement mortar.

The base of the chimney is eleven feet in diameter and at the smaller section near the top it is seven feet three inches in diameter. The cap is cast-iron, made in eight sections and bolted together with composition bolts, and weighs three and four-tenths tons.

The chimney has an inner shaft four feet inside diameter which extends to the top, and the smoke flue enters the chimney eighteen feet above the boiler room floor. The foundation is nineteen feet square and starts on a layer of compact gravel seven feet below the surface of the ground. There is an opening at the base of the chimney for taking out the soot.

The pump well is located at the east side of the engine room cellar and the east wall is also a portion of the engine house foundation. The well is ten feet eight inches wide by twenty-one feet eight inches long, and the elevation of the bottom is 136.5 feet. The sides are built of cement rubble masonry, and the inside of the well is lined with bricks four and eight inches in thickness, and the bottom is cement concrete and bricks, and is water tight. The screen chamber is located at the southeast corner of the well, and there are two sets of copper wire screens of one-fourth inch mesh. At the end of the 24-inch intake pipe there is a sluice gate to shut off the water from the well when necessary. Scales have been built into the floor of the boiler house for weighing all the coal used in the boilers.

At the rear of the pumping station a retaining wall 178 feet in length has been built of dry rubble along the lake and the grounds graded and sown with grass seed.

During the fall a dwelling house and stable have been built near the pumping station for the use of the engineer.

ENGINES AND BOILERS.

The bottom of the foundation for the engines is built of granite about one foot thick, and the upper part of the foundations is built of bricks laid in cement mortar, excepting the top, which is finished with fine cut granite.

There are two Worthington high duty pumping engines, each having two high pressure cylinders 30 inches in diameter, and two double-acting water plungers 15¼ inches in diameter. The engines will deliver 51.62 gallons per revolution when making the stipulated stroke of 18 inches, after making a deduction of 5 per cent. for slip. Each engine was guaranteed to deliver into the reservoir 3,000,000 gallons in twenty-four hours against a dynamic head of 254 feet. The static head is about 250 feet.

FORCE MAIN.

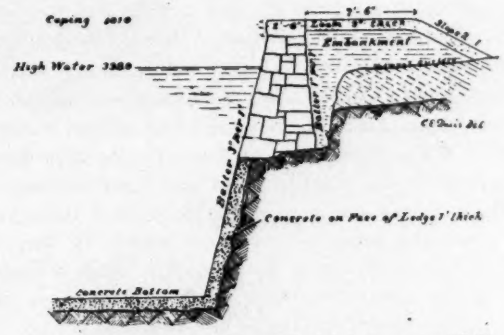
The force main is cast-iron and 20 inches in diameter and was laid during the fall of 1893, excepting a short piece at the reservoir which is 24 inches in diameter. There are two classes of pipe: Class B varies in weight from 2,400 to 2,464 pounds, and class A from 1,980 to 2,080 pounds per lengths of 12.46 feet.

There are 7 gates, 13 hydrants, 6 air-valves, 2 10-inch and 5 6-inch blow-offs located along the force main. From the engine room cellar to the gate chamber at the reservoir there are 19,076 feet of 20-inch and 80 feet of 24-inch pipe, making a total distance of 3.63 miles.

RESERVOIR.

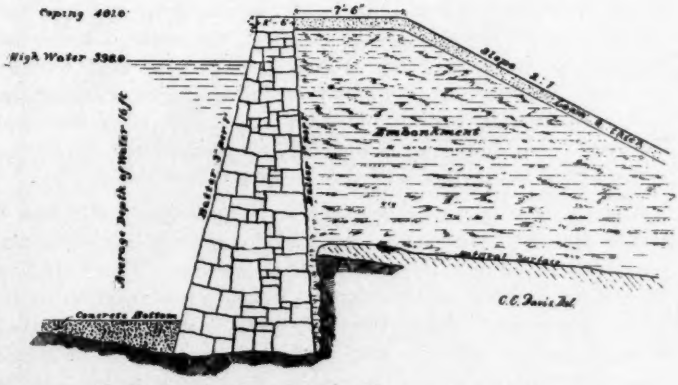
Many depressions in the bottom were filled to subgrade with the best puddling material found on the work, which was thoroughly wetted and afterwards made compact by constant teaming over the bottom. There were several fissures in the ledge along the south side which were filled with cement grout. The bottom is covered with cement concrete, having an average thickness of ten inches, including a layer of cement mortar about three-fourths of an inch thick. The face of the ledge on the north, east, and west sides is covered with concrete to the top, which varies in thickness from six inches to three feet, and the average thickness is about one foot. The excavation did not furnish suitable stone for the face of the wall. The face stone and coping came from Bodwell's quarry and the back of the wall came from the excavation. The wall is laid in

cement mortar having a batter on the face of three inches to the foot, and is thirty inches wide at the top under the coping. The coping is the full width of the wall, one foot thick, and the end joints are filled with Portland cement.



Section of Combined Ledge & Masonry Wall at AB

Scale of Sections 1 inch = 1 foot



Section of Masonry Wall at CD

SECTIONS OF EMBANKMENT, HIGH SERVICE RESERVOIR.

All the corners of the reservoir are circular in shape excepting the one at the southeast, which is cut off at an angle of forty-five

degrees, so as to form the front wall of the gate chamber and to give more embankment, thus strengthening the reservoir at this place.

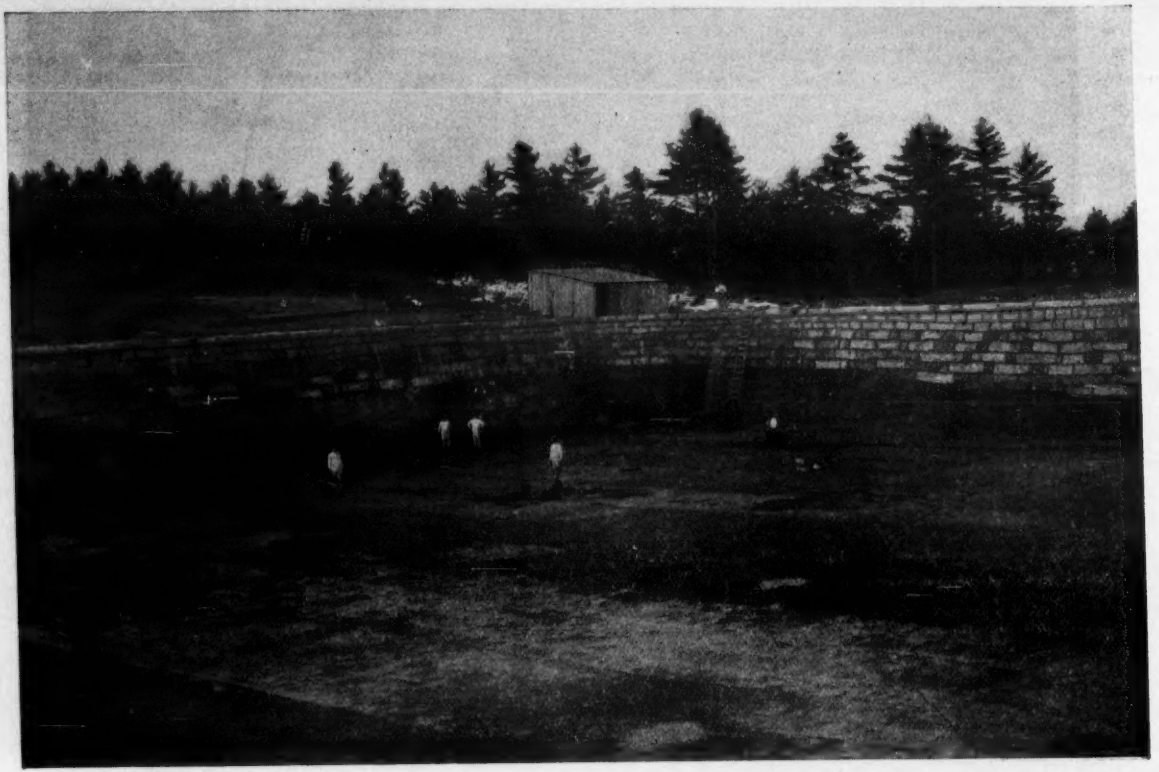
The bottom of the reservoir is not a uniform plane, as the surface was governed largely by the way in which the excavation could be made. The wall at the northeast corner is nineteen feet, and at the southwest corner twenty-two feet high.

The bottom has a slope towards the drainpipe at the gate chamber, excepting a small portion at the southwest corner, which is nearly two feet below the drainpipe. At this place the rock was very rotten, being mostly composed of mica, and it was considered advisable to take out this objectionable material even if there was a small portion below the grade originally intended. To have filled it to grade with concrete would have incurred quite a large expense without giving sufficient benefit, but the depression will form a place for the deposit of mud, which is desirable.

Six springs were found along the north side, and three near the southwest corner. Small iron pipes were built into the masonry at these places. At the time the reservoir was filled only two were draining a very small quantity of water into the reservoir. The top of the embankment is 10 feet wide, including the masonry, and has an outward slope of two to one, and was made in horizontal layers of the excavated earth, thoroughly wetted and made solid by constantly teaming over it and by ramming the portions nearest the wall. The outside was covered with loam found on the work and sown with rye and grass seed. The elevation of the top of the embankment is 401 feet and high water is 3 feet lower.

The inside of the gate chamber is 15 feet wide by 15 feet 6 inches long and 20 feet deep. It is divided into two compartments, one for the weir and the other for the screens. There are four 20-inch sluice gates; two of them are located 8 feet apart vertically, so that water can be drawn from two levels. When the reservoir is full it would be better to draw through the upper gate, for should an accident happen to the force main, there would be less liability of a large quantity of water being drawn of. A permanent weir of southern pine, having its edges of steel, is built into the masonry. The elevation of the crest is 397.29 feet.

METHOD OF BUILDING CONCRETE WALL, HIGH SERVICE RESERVOIR.



CONCRETE ON SIDES AND BOTTOM, HIGH SERVICE RESERVOIR.

GATE HOUSE.

The exterior walls are composed of stone having quarry faces, which came from the reservoir excavation, care being taken to select those having the most color, and the trimmings are granite from Bodwell's quarry. The interior walls were built of the best face-brick laid in red lime and cement mortar.

The floor is supported by brick arches, and the top will be covered with Portland cement mortar.

The ceiling is Georgia pine, nailed to the rafters, and will have two coats of hard oil finish.

The gate house is nineteen feet ten inches square, and has a hip roof covered with red slates and terra cotta hip rolls.

CONCRETE ON SIDES AND BOTTOM, HIGH SERVICE RESERVOIR.

OBITUARY.

JOHN L. HARRINGTON.—Superintendent of Water Works, Cambridge, Mass., member of the Finance Committee of this Association. Died August 16th, 1895, aged 39 years and 3 months. Joined this Association June 15th, 1887.

Mr. Harrington was employed in the office of the City Engineer of Cambridge for several years, where his efficient service led to his appointment as inspector in the water department. From this position he was promoted to foreman, and he succeeded to the office of Superintendent in 1894.

Mr. Harrington was very systematic in his work and managed the affairs of his department with great ability and his strong character and unwavering honesty won him many friends.

MARSHALL M. TIDD.—Civil Engineer. Died Aug. 20th, 1895, aged 68 years, 19 days. Joined this Association June 18th, 1885.

Mr. Tidd was a native and resident of Woburn, Mass. At the age of 19 he entered the employ of Mr. Storrow at Lawrence, Mass., and later opened an office in Boston where he has been located for the past 45 years. As an expert hydraulic engineer Mr. Tidd was well known, having served as consulting or constructing engineer for more than 50 different systems of water works as also for many systems of sewerage and dry docks. He was a member of the Boston Society of Civil Engineers and the American Society of Civil Engineers, and was at one time Water Commissioner for his native city. He took an active interest and was a frequent participant in the discussions at our meetings and was well known and respected by all our members.

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